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US DEPARTMENT OF ENERGY
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Enterprise Construction Management Services

Revision 0

Addendum 1

Waste Treatment and Immobilization Plant
High-Level Waste Treatment

Analysis of Alternatives

BPA Number: DE-NA0002895

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ACRONYMS

ACD	Amended Consent Decree
AoA	Analysis of Alternatives
AOP	air operating permit
ASME	American Society for Mechanical Engineers
BOF	Balance of Facilities
CDR	conceptual design report
CH-TRU	contact handled transuranic waste
DFHLW	direct feed high-level waste
DFLAW	direct feed low-activity waste
DOE	U.S. Department of Energy
DST	double shell tank
DWP	Dangerous Waste Permit
ECMS	Enterprise Construction Management Services
EMF	Effluent Management Facility
ETF	Effluent Treatment Facility
FFV	Filter Feed Vessel
ft^2	square foot/feet
gpm	gallon(s) per minute
HEMF	HLW Effluent Management Facility
HEPA	high efficiency particulate air
HFPEM	HLW Feed Preparation and Effluent Management Facility
HFPF	HLW Feed Preparation Facility
HFPV	HLW Feed Preparation Vessel
HFV	HLW Feed Vessel
HIHTL	Hose-In-Hose Transfer Lines
HLW	high-level waste
HVAC	heating/ventilation/air conditioning
ICM	in-container mixer
IDF	Integrated Disposal Facility
IHLW	immobilized high-level waste
IHS	Interim Hanford Storage
ILAW	immobilized low activity waste
IX	ion exchange
IXC	ion exchange columns
kgal	kilogallons
LAW	low activity waste
LAWST	LAW Supplemental Treatment (facility)
LCC	Lifecycle cost
LCCE	Lifecycle Cost Estimate
LDR	land disposal restrictions
LERF	Liquid Effluent Retention Facility
LFE	LAW Feed Evaporator
LILO	Load-in/Load-out
LLW	low level waste
m^3	cubic meter(s)
MAR	material at risk
MFP	melter feed preparation
MFV	Melter Feed Vessel
Mgal	million gallons
MGS	modular grout system
MLLW	mixed low level waste
MTG	metric tons of glass
MWF	Mixed Waste Facility
NPH	Natural Phenomena Hazard
NRC	Nuclear Regulatory Commission
ORP	Office of River Protection
OSGF	On-Site Grout Facility
OTC	on-site transportation containers
PCB	polychlorinated biphenyl
PFNW	Perma-Fix Northwest
PHA	preliminary hazard analysis
PT	Pretreatment (Facility)
PV	present value
RCA	Radiological Control Area
RCRA	Resource Conservation and Recovery Act

RLD	Radioactive Liquid Waste Disposal
RPP	River Protection Project
SALDS	State Approved Land Disposal Site
SC	Safety Class
SDC	seismic design category
SE	southeast
SEIS	Supplemental Environmental Impact Statement
SEPA	State National Environmental Policy Act
SLWT	Secondary Liquid Waste Treatment
SME	subject matter expert
SRS	Savannah River Site
SS	Safety Significant
SSC	structures, systems, and components
SST	single shell tank
STB	Stabilization Building
SW	southwest
TFPT	Tank Farm Pretreatment
TOE	total operating efficiency
TPC	total project cost
TRA	Technology Readiness Assessment
TSCA	Toxic Substances Control Act
TSCR	Tank Side Cesium Removal (facilities)
TWCSF	Tank Waste Characterization and Staging Facility
VE	value engineering
WAC	Waste Acceptance Criteria
WCS	Waste Control Specialists, LLC
WDOH	Washington Department of Health
WFD	waste feed delivery
WRF	Waste Retrieval Facility
WRPS	Washington River Protection Solutions
WSU	Waste Solidification Unit
wt %	percent by weight
WTP	Waste Treatment and Immobilization Plant
WTV	Waste Transfer Vault
yd^3	cubic yard(s)

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of River Protection (ORP) tasked Enterprise Construction Management Services (ECMS) with performing an independent Analysis of Alternatives (AoA) for the Waste Treatment and Immobilization Plant (WTP) High-Level Waste (HLW) project. The AoA was conducted from May 2019 through August 2020, and Revision C to the AoA Report was submitted on August 20, 2020. Minor non-content typographical and formatting edits are included in Revisions D and E, dated April 16, 2021 and May 12, 2022, respectively, issued with this Addendum. One of the major guiding assumptions of the AoA, and also a key screening criterion (Section 3.1 of the AoA Report), was that all low activity waste (LAW) and HLW would be immobilized by vitrification.

The AoA Steering Committee (see Section 11.1 of the AoA Report) subsequently requested additional analysis of a new alternative using a phased startup approach and, unlike the original alternatives that only considered vitrification as a viable treatment for LAW, assumed treatment of LAW by both vitrification and grouting. This addendum describes the approach, assumptions, analysis, and results, as compared to the AoA alternatives, of the new Alternative 18.

Alternative 18 Summary Description

Alternative 18 was developed by combining the lower up-front capital costs of AoA Alternative 17 (direct feed HLW [DFHLW] from double-shell tanks (DSTs) without HLW effluent management), with beneficial lifecycle cost (LCC) and schedule attributes of other AoA alternatives using a phased startup approach for treatment facilities. This approach allows startup of LAW and HLW treatment, respectively, in Phases 1 and 1B, with minimal capital investment in comparison to other alternatives. Each phase is briefly described below. Process and facility details, respectively, can be found in Sections 3 and 4 of this Addendum.

- Phase 1 uses the flowsheet from AoA Alternative 17. Tank waste from the Southeast (SE) Quadrant is treated using direct-feed low-activity waste (DFLAW) beginning in 2023.
- Phase 1B begins in 2025 and includes off-site treatment and disposal of the Southwest (SW) Quadrant waste, to include pretreatment by an SY Tank Farm tank side cesium removal (TSCR) unit beginning in 2026. In the latter part of Phase 1B (2033), HLW treatment begins using the DFHLW approach. The Phase 1 systems and facilities continue to operate as a fully integrated flowsheet throughout Phase 1B. Phase 2 facilities are constructed as funding allows.
- Phase 2 begins in 2050 using the Alternative 14 flowsheet for HLW pretreatment in the HLW Feed Preparation and Effluent Management (HFPEM) facility. Off-site grout treatment is discontinued. Phase 2 also includes new Waste Retrieval Facilities (WRFs) for Northeast and Northwest Quadrant single-shell tank (SST) retrieval, a new LAW Feed Evaporator (LFE) for concentration of LAW feed, a new On-Site Grout Facility (OSGF) for LAW treatment, and a new Effluent Treatment Facility (ETF) for treatment of process condensate. Except for using the OSGF to treat the remaining LAW in the SW Quadrant, the Phase 1 and Phase 1B systems and facilities continue to operate as a fully integrated flowsheet throughout Phase 2.

Approach

Realizing that Alternative 18 is a departure from the original assumptions of the AoA, the AoA team made a concerted effort to analyze Alternative 18 using a similar methodology. As with the AoA, Alternative 18's analysis was partly based on the Washington River Protection Solutions' (WRPS) TOPSim flowsheet modeling results[1]. Using these modeling results, information obtained from numerous data requests, numerous working sessions, and subject matter expert (SME) judgment, the AoA team developed the following products to aid in the Alternative 18 analysis:

- Process flowsheets and descriptions

[1] High-Level Waste Analysis of Alternatives Model Results Report, 2021, RPP-RPT-61957, Rev 2

- Notional facility diagrams and layouts
- Facility descriptions
- Capital cost estimates
- Lifecycle cost estimates (LCCE)

The AoA team also used the previously developed risk register (see Appendix F of the AoA Report) to qualitatively analyze threats and opportunities for Alternative 18.

Similar to the AoA, both unconstrained funding and constrained funding cases were analyzed.

Major Assumptions

Key assumptions for Alternative 18 are listed below. Additional details are provided in Section 2 of this Addendum. For reference, guiding assumptions for the AoA can be found in Section 3.2 of the AoA Report.

- LAW that is immobilized by grouting can be disposed of at the Integrated Disposal Facility (IDF).
- Both HLW melters are installed and operated through completion of tank waste treatment.
- The constrained funding analysis, where applicable, uses a flat $2.5B annual operating budget based on Steering Committee and ORP direction.
- Permits, as applicable, can be obtained in a timely fashion to meet the proposed schedule.
- Unconstrained schedule assumes full resource and material availability to meet major milestones.

Alternative 18 Summary Results

Cost and Schedule

The AoA team analyzed constrained and unconstrained funding cases for Alternative 18 with the same methods used for the other alternatives. The unconstrained case assumed that all necessary funding is available to construct the required capital projects and operate the necessary facilities to achieve the proposed milestone schedule. The results from the unconstrained cost analysis are provided in Table 1. Additional details on the basis of estimates for Alternatives 1, 2, 5, 14, 15, 16, and 17 can be found in Section 8 and Appendix E of the AoA Report. Estimate details for Alternative 18 can be found in Sections 5.2 and 8.3 of this Addendum.

Table 1: Unconstrained Funding Results

#	Alternative Name	TPC ($B)	LCC ($B)	PV ($B)
1	HLW Pretreatment in Pretreatment Facility (Baseline Case)	38.0	341	151
2	HLW Pretreatment in the HLW Feed Preparation Facility (HFPF)	41.0	215	125
5	Repurpose Pretreatment (PT) Facility for HLW Pretreatment and HLW Effluent Management (HEMF)	39.3	217	123
14	New HFPF (with Filtration) and New HEMF	33.9	212	119
15	DFHLW and HLW Effluent Processing in New HEMF	35.2	214	121
16	HLW Pretreatment in DSTs and in Feed Preparation Tanks in New HEMF	35.6	213	121
17	DFHLW Single Melter HLW without Evaporators or LAW Supplemental Treatment (LAWST) Facility	9.0	5,099	423
18	HLW Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	20.0	199	97

TPC – total project cost; PV – present value

Both the unconstrained and constrained funding case provide for the completion of the HLW facility in FY33 to enable direct feed treatment. One notable difference between the two cases is the funding profile and schedule. The unconstrained case starts grouting for off-site disposal in FY24 with a significant ramp up to FY27. The constrained case envisions the start in FY28 with a more modest ramp up.

The constrained cost analysis assumed an ORP operating budget of $2.5B annually. The AoA team determined that sufficient funding would not be available to complete the necessary capital projects. To help mitigate projected shortfalls, the AoA team analyzed whether delaying certain capital projects in preference of operations activities would result in a better profile. In a best-case scenario, available funding was exceeded during FY43. Further details on the constrained cost analysis can be found in Section 5.3. Because of this, Alternative 18 was determined to be non-viable in the constrained funding case. Alternative 18 was therefore not analyzed from a risk or scoring perspective, similar to Alternatives 1 and 5 in the original AoA.

At the request of the Steering Committee, the AoA team ran a cost sensitivity to determine the minimum annual funding increase to mitigate funding shortfalls of the $2.5B annual constraint. In addition to Alternative 18, the sensitivity was also applied to Alternatives 1 and 5 from the original AoA since they could not construct all necessary facilities for operations.

The AoA team determined that an annual increase in funding of 1.5% per year, beginning in FY2025 would have the following results:

- Alternative 1: The HLW/PT Facility can be completed in FY2046
- Alternative 5: The HLW/PT Facility can be completed in FY2039
- Alternative 18: Funding shortfall is mitigated

In order to complete HLW/PT by FY2034, as required, the annual funding increases for Alternatives 1 and 5 are 6% and 4.5%, respectively.

Qualitative Risk Assessment

The AoA team used the same risk register as all other alternatives to evaluate Alternative 18 in the unconstrained case. Forty-one threats and five opportunities were evaluated by the AoA team over three categories: Project/Technical (pre-CD-4), Operations (post-CD-4), and Programmatic (outside control of the project). Overall results of the risk assessment are listed in Table 2.

Table 2: Unconstrained Risk Assessment Results

#	Alternative Name	Project/Technical Risk Rating	Operations Risk Rating	Programmatic Risk Rating
1	HLW Characterization and Staging in New Tank Waste Characterization and Staging Facility (TWCSF) and HLW (and LAW) Pretreatment in the PT Facility (Baseline Scenario)	Moderate (2.82)	Moderate (2.88)	Moderate (2.92)
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	Low (2.47)	Moderate (2.69)	Moderate (3.15)
5	HLW Pretreatment and Effluent Management in the Repurposed PT Facility	Moderate (2.94)	Moderate (2.81)	Moderate (3.08)
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	Low (2.47)	Moderate (2.81)	Moderate (3.15)
15	DFHLW from DSTs and Effluent Management in New HEMF	Moderate (2.65)	Moderate (3.06)	Moderate (3.23)
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	Moderate (2.65)	Moderate (3.06)	Moderate (3.23)
17	DFHLW from DSTs without HLW Effluent Management	Low (2.29)	Moderate (3.06)	Moderate (3.15)
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	Moderate (2.82)	Moderate (2.88)	Moderate (3.31)

Threats rated ‘Very High’ for Alternative 18 are listed below. At least one other alternative also was rated ‘Very High’ for each of these threats, and is also identified:

- Changes in mission or execution requirements results in a need to reevaluate the HLW treatment mission, resulting in project delays or cost impacts (Alternatives 17 and 18)
- Contractor performance problems executing design, management, construction, startup, and commissioning, resulting in delays or cost impacts (All alternatives, except 17)
- Permitting approval delays. (Alternatives 15, 16, 18)
- Funding shortfalls, resulting in cost or schedule impacts (All alternatives, except 17)
- Deviation from current regulatory framework (Alternatives 15, 16, 17, and 18)

Alternative 18 had a similar overall risk rating to all other alternatives in the Operations category, and also a similar rating to Alternatives 5, 15, and 16 for the Project/Technical category. Alternative 18 did have the highest Programmatic risk rating of all alternatives, primarily driven by potential permitting and funding delays, as well as deviation from the current regulatory framework.

Further details on the risk assessment can be found in Sections 6.1 and 8.1 of this Addendum.

Alternative 18 Evaluation

Alternative 18 was evaluated using the same evaluation criteria as all other alternatives under the unconstrained case. This included generating capital cost estimates, performing a LCC analysis, conducting a qualitative risk assessment, scoring against evaluation criteria, and a sensitivity analysis. See Section 7 and Appendix G in the AoA Report for additional details on how the evaluation criteria were weighted and scored for Alternatives 1, 2, 5, 14, 15, 16, and 17. Scoring details for Alternative 18 can be found in Sections 6.2 and 8.2 in this Addendum.

The addition of Alternative 18 necessitated a scoring reevaluation for the unconstrained funding case. The constrained funding cost analysis also concluded that Alternative 18 could not construct all the necessary facilities for the HLW mission, making Alternative 18 non-viable in the flat $2.5B per year constrained funding case studied for the AoA.

After reevaluating scoring for the unconstrained funding case, Alternative 14 remained the highest scoring alternative (76.0), with Alternative 18 (73.0) second highest. The next grouping of alternatives are Alternatives 2 (70.0), 15 (69.0), 16 (68.0), and 5 (66.0). Alternative 1 scores four points lower (62.0), with Alternative 17 remaining the lowest score (58.0). Summary results are shown in Table 3.

Table 3: AoA Results - Unconstrained Funding

#	Weighted Score	Start Date HLW Treatment Operations	Total Project Cost ($B)	Project/ Technical Risk	Operational Risk	Programmatic Risk	LCC (PV, $B)	Complete HLW Treatment	Increased Operational Flexibility	# IHLW Canisters Produced	# ILAW Containers Produced	Volume of Secondary Liquid Effluent Produced
1	62.0	12/31/2033	38.0	Moderate	Moderate	Moderate	151	08/2084	Somewhat Meets	9,500	93,900	17 Mgal
2	70.0	12/31/2033	41.0	Low	Moderate	Moderate	125	07/2061	Fully Meets	8,200	101,400	34 Mgal
5	66.0	12/31/2033	39.3	Moderate	Moderate	Moderate	123	09/2064	Fully Meets	9,500	97,800	30 Mgal
14	76.0	12/31/2033	33.9	Low	Moderate	Moderate	119	09/2064	Fully Meets	9,500	97,800	30 Mgal
15	68.0	12/31/2033	35.2	Moderate	Moderate	Moderate	121	05/2064	Generally Meets	8,100	103,600	32 Mgal
16	69.0	12/31/2033	35.6	Moderate	Moderate	Moderate	121	10/2062	Generally Meets	8,100	102,000	31 Mgal
17	58.0	12/31/2033	9.0	Low	Moderate	Moderate	423	2168+	Doesn't Meet	14,900+	67,000+	8 Mgal
18	73.0	12/31/2033	20.0	Moderate	Moderate	Moderate	97	09/2075	Generally Meets	12,000	68,000*	22Mgal

IHLW – immobilized high-level waste, ILAW – immobilized low activity waste
* Alternative 18 produces 534,000 of grouted LAW in addition to 68,000 containers of vitrified ILAW

Sensitivity Analysis

The AoA team performed the same sensitivity scenarios for Alternative 18 as were performed in the unconstrained case for all other alternatives. The results from the sensitivity analysis are shown in Table 4.

In the Base Case and all but one of the eight sensitivity scenarios, Alternative 14 is the highest ranked. The exception is Scenario 6, where only cost, schedule, and risk are considered, and for which Alternative 14 drops one rank to second place behind Alternative 18. Alternatives 14 and 18 tie for top ranking in Scenario 7, which eliminates Evaluation Criteria 7 and 8. These criteria are related to the volumes of HLW and ILAW generated.

Table 4: Unconstrained Case Sensitivity Analysis Results

	Baseline		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
ALT #	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK
1	62.0	7	61.1	7	58.3	7	71.1	5↑	52.5	7
2	70.0	3	66.7	2↑	75.0	2↑	78.9	2↑	62.5	3
5	66.0	6	66.7	2↑	72.9	6	73.7	3↑	57.5	6
14	76.0	1	72.2	1	79.2	1	81.6	1	70.0	1
15	68.0	5	63.9	5	72.9	5	71.1	6↓	60.0	5
16	69.0	4	66.7	2↑	74.0	4	72.4	4	61.3	4
17	58.0	8	50.0	8	39.6	7	55.3	8	47.5	8
18	73.0	2	63.9	5↓	75.0	3↓	69.7	7↓	66.3	2
	Baseline		**Scenario 5**		**Scenario 6**		**Scenario 7**		**Scenario 8**	
ALT #	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK
1	62.0	7	63.0	7	50.0	7	60.9	7	60.0	4↑
2	70.0	3	67.4	4	61.7	3	70.7	3	65.0	3
5	66.0	6	63.0	7↓	53.3	6	66.3	6	70.0	1↑
14	76.0	1	73.9	1	70.0	2↓	77.2	1	70.0	1
15	68.0	5	67.4	4↑	61.7	3↑	68.5	5	55.0	6↓
16	69.0	4	68.5	3↑	61.7	3↑	69.6	4	60.0	4
17	58.0	8	63.0	6↑	50.0	7↑	58.7	8	40.0	8
18	73.0	2	72.8	2	71.7	1↑	77.2	1↑	50.0	7↓

Rank indicates the alternatives' order based on scoring, with a rank of 1 corresponding to the highest score.

Arrows indicate increase (↑) or decrease (↓) in rank relative to baseline rank.

1 Introduction

1.1 Tasking

After completing the Waste Treatment and Immobilization Plant (WTP) high-level waste (HLW) Analysis of Alternatives (AoA) in August 2020, the Steering Committee (see Section 11.1 of the AoA Report) requested that a new Alternative 18 be analyzed that used a phased treatment approach. The phased approach would combine the up-front affordability of Alternative 17 with the lifecycle cost (LCC) and schedule of other alternatives via a phased startup of treatment facilities. Washington River Protection Solutions (WRPS), with subject matter expert (SME) input, developed and executed TOPSim modeling for the new Alternative 18.

Enterprise Construction Management Services (ECMS) received initial modeling results on January 8, 2021, and was tasked to analyze Alternative 18 using a methodology like that described in the August 2020 AoA Report (AoA Report). Alternative 18 is a foundational departure from the original assumptions of the AoA, namely that all HLW would be treated by vitrification. However, the AoA team made a concerted effort to analyze Alternative 18 using a similar methodology. Any departures from the original methodology are described in this Addendum.

Similar to the other AoA alternatives, much of the analysis of Alternative 18 was, in part, based on Washington River Protection Solutions' (WRPS) TOPSim flowsheet modeling results. Using these modeling results, the information obtained from numerous data requests and collaborative working sessions, and SME judgment, the AoA team developed the following products to aid in the analysis of Alternative 18:

- Process flowsheets
- Process descriptions
- Notional facility diagrams and layouts
- Facility descriptions
- Capital cost estimates
- LCC estimates

The AoA team also used the previously developed risk register (see Appendix F of the AoA Report) to qualitatively analyze threats and opportunities for Alternative 18.

As with the other AoA alternatives, both unconstrained funding and constrained funding cases were analyzed for Alternative 18.

1.2 Background

Project background for the WTP HLW mission can be found in Section 2.1 of the AoA Report.

2 Assumptions, Constraints, and Facts

- Low activity waste (LAW) immobilized by grouting can be disposed of on site in the Integrated Disposal Facility (IDF).
  - Resource Conservation and Recovery Act (RCRA) organics and polychlorinated biphenyls (PCBs) do not exceed land disposal restrictions (LDRs), or an LDR variance can be obtained.
  - An IDF performance assessment can demonstrate that Tc-99, I-129, and nitrate meet long-term performance objectives.
- The Perma-Fix Northwest Richland Inc. (PFNW) facility can increase capacity of its in-container mixing (ICM) system for treatment (grouting) of LAW from West Area tanks in Phase 1B (2026 – 2050).
- Both HLW melters are installed and operate until completion of the tank waste treatment mission.
- The constrained funding analysis, where applicable, uses a $2.5B annual operating budget based on Steering Committee and Office of River Protection (ORP) direction.
- The unconstrained case assumes that all necessary funding is available to meet schedule milestones for construction, startup, commissioning, and operations.
- Permits, as applicable, can be obtained in a timely fashion to meet the schedule.
- AoA results rely, in part, on data outputs from the TOPSim flowsheet modeling, as documented in Rev B to the Model Results Report[1].

3 Alternative 18 Process Descriptions

Alternative 18 is based on a phased approach for treatment of the LAW and HLW tank waste. This approach allows starting LAW and HLW treatment, respectively, in Phases 1 and 1B, with minimal capital investment. Phase 1B also adds the capability to treat and dispose of the West Area LAW in off-site facilities. During the latter part of Phase 1B, the facilities needed for Phase 2 are constructed as funding allows. In Phase 2, the higher capacity LAW pretreatment and treatment facilities and the HLW pretreatment and effluent processing facility that were constructed on-site in Phase 1B are placed in service. Once the Phase 2 facilities are in service, off-site treatment and disposal of the West Area LAW is discontinued.

The process functions and the facilities assigned to perform these functions, are described in Sections 3 and 4 of this Addendum. These process functions and facilities are generally based on the process modelling inputs and assumptions that are described in Model Scenario Request Form[2]. While Alternative 18's phases are distinct and start up one after the other, all phases eventually run in parallel as a combined process flowsheet. Phasing is briefly described below:

- Phase 1 starts when LAW treatment begins with completion of hot commissioning of the LAW Vitrification Facility.
- Phase 1B starts when retrieval of the Southwest (SW) Quadrant single shell tanks (SSTs) begins in 2025. Phase 1 facilities remain in operation and continue to treat waste in parallel with Phase 1B.
- Phase 2 starts in 2050 with Northeast (NE) Quadrant SST retrievals, while Phase 1 and Phase 1B[3] process functions and facilities continue operations.

The AoA team decided to assign the LAW supplemental treatment (LAWST) capability to a new On-Site Grout Facility (OSGF). The OSGF would be designed to have the added capacity to treat the remaining LAW in the West Area tanks. The WRPS process modeling that was in progress before these changes was based on continuation of off-site treatment and disposal of the West Area LAW throughout Phase 2. The changes made by the AoA team did not appreciably affect the WRPS process model developed for Alternative 18. Other than changes to the volume and disposition of grout produced in Phase 2, the modeling results are as reported in Rev 2 of the Modeling Results Report[1].

The new processing facilities that are needed and the required operational timeframes for Phases 1, 1B, and 2 are identified in Table 5. The facilities identified in Table 5 do not include the infrastructure modifications that are required to the double shell tank (DST) system. These modifications are in the planning stages and will be funded by multiple

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[2] MR-50638 Model Request Form, Analysis of Alternatives Scenario Alternative 18 Phased Startup
[3] The Phase 1B off-site treatment and disposal facilities are not used in Phase 2.

projects on an as-needed basis to replace or add infrastructure (e.g., waste transfer pumps, pits, and leak detection and DST process support and utility systems) to support waste feed delivery (WFD).

The constrained funding case will require sequencing the construction projects to keep the capital and operating expenditures under the limits established for this AoA. The list below reflects only the operational need dates that were assumed for the WRPS process modeling for Alternative 18[4] . To balance the overall spending profiles from year to year, construction of some of the facilities may need to be completed earlier than required, or they may need to be constructed over a longer timeline than would be optimal. These funding considerations are addressed in Section 5 of this Addendum.

Table 5: Facilities Required for each Phase

Facility	Required Startup Date	Operations Completion Date
Phase 1		
AP Tank Side Cesium Removal (TSCR)	3/2023	3/2028[5]
LAW Vitrification Facility	12/31/2023	9/2075
WTP Effluent Management Facility (EMF)	12/31/2023	9/2075
Modified Effluent Treatment Facility (ETF)	12/2023[6]	1/2051
Phase 1B		
SY Tank Farm TSCR	1/2026	9/2068
SY Load-in/Load-Out (LILO) Station	1/2026	9/2068
In-Container Mixer in PFNW Facility	1/2026	1/2051
Waste Control Specialist Facility	1/2026	1/2051
AP Tank Farm Pretreatment (TFPT)	3/2028[7]	12/2050
HLW Vitrification Facility	12/31/2033[8]	9/2075
Waste Transfer Vault (WTV)	12/31/2033	9/2075
Interim Hanford Storage (IHS)	1/2034	9/2075
Cross-Site Transfer System Slurry Line	12/2036[9]	9/2068
Phase 2		
HFPEM	12/2050	9/2075
East Area Waste Retrieval Facility (WRF)	12/2050	1/2071[10]
West Area WRF	3/2054	9/2068[11]
Higher Capacity TFPT	12/2050[12]	9/2075

[4] High-Level Waste Analysis of Alternatives Model Results Report, 2021, RPP-RPT-61957, Rev 2
[5] The first AP TSCR to be installed (also referred to as the TSCR Demonstration Facility) will have a design life of 5 years. A higher capacity Tank Farm Pretreatment (TFPT) unit will be installed before the end of the design life of the first TSCR unit.
[6] As discussed in section 3.1.9 of this Addendum, the existing ETF does not have the required treatment capabilities to treat the process condensate generated during WTP operations. Before Phase 1 operations, the facility will require modifications to add more robust treatment systems and provide the capability to solidify the brine from the evaporator in the Secondary Treatment Train.
[7] The AP TFPT replaces the TSCR. The AP TFPT will have a pretreatment capacity of 2x the TSCR (10 gallons per minute [gpm] vs. 5 gpm).
[8] The WRPS process model assumes that the HLW Vitrification Facility starts up (i.e., coincident with completion of Hot Commissioning) on 12/31/2033, which is consistent with the date specified in the Amended Consent Decree (ACD).
[9] The Replacement Cross-Site Transfer System was completed in the 1990 timeframe. An evaluation of the condition of the slurry line and associated support systems was completed in 2012 and is documented in the Cross-Site Slurry Line Evaluation Report, RPP-RPT-47572, Rev 0. The report concluded that the slurry line and support systems needed to be repaired/replaced.
[10] The East Area WRF supports retrieval of B complex SSTs. These retrievals will be complete in 8/2070. Sludge remaining from retrievals will be removed from the WRF in 1/2071.
[11] West Area WRF supports retrieval of T complex SSTs. These retrievals will be complete in 9/2068, and residual sludge will be removed from the WRF shortly thereafter.
[12] The WRPS process modeling predicts that the AP TFPT pretreatment capacity needs to increase by a factor of 2x (from 10 gpm to 20 gpm) before starting Phase 2 operations.

Facility	Required Startup Date	Operations Completion Date
LAW Feed Evaporator	12/2050	9/2075
OSGF	12/2050	9/2075
AP LILO Station	12/2050	9/2068
New Higher Capacity ETF	12/2050	9/2075
Tank Waste Treatment Mission Completion		9/2075

3.1 Phase 1 Process Descriptions

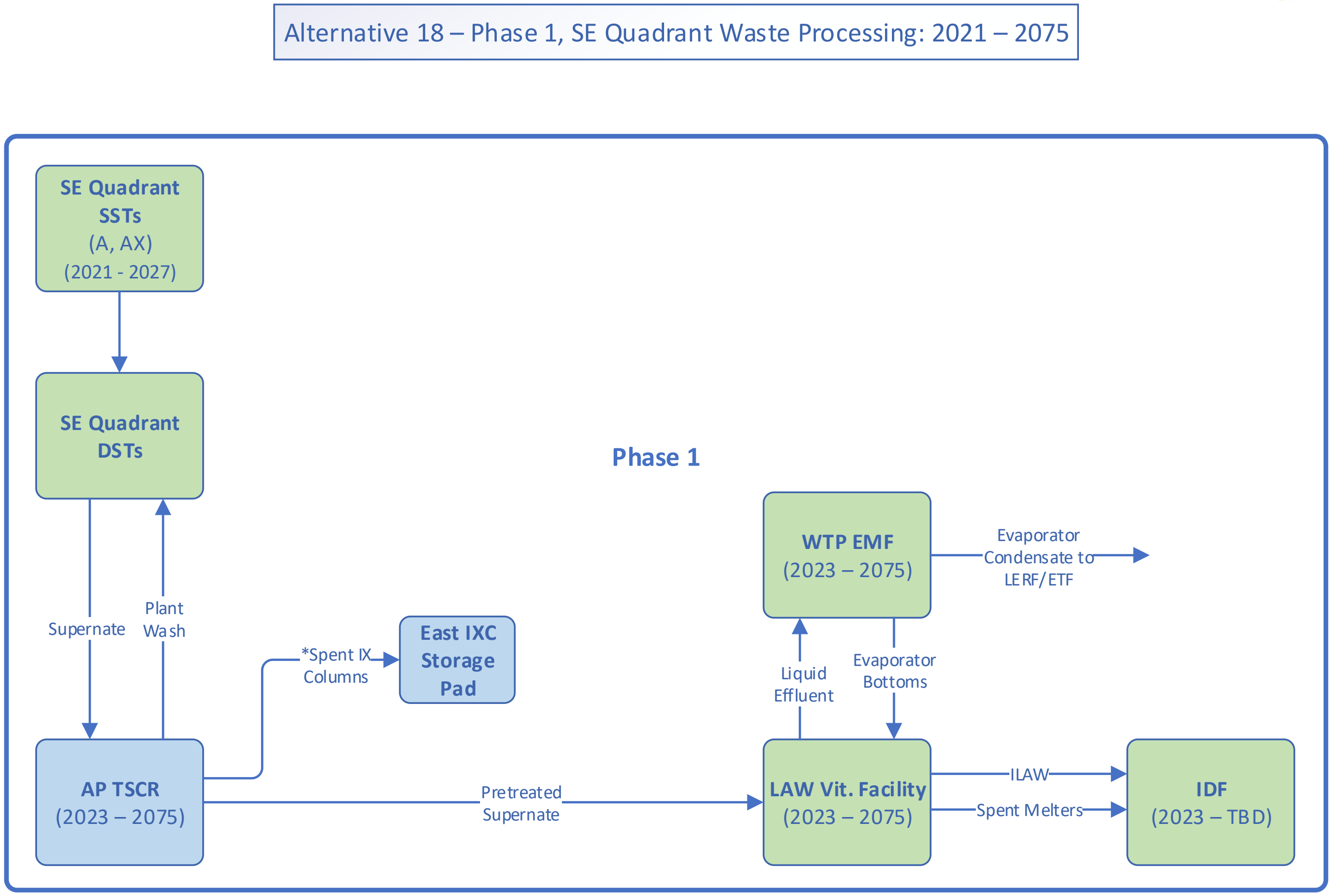
In Phase 1, LAW pretreatment and treatment will begin as part of the direct-feed HLW (DFLAW) approach as described in Section 2.8 of Appendix A in the AoA Report. In this phase, LAW treatment will start in 2023[13] once hot commissioning of the LAW Vitrification Facility is completed as required by the Amended Consent Decree (ACD) (ECF No. 59)[14]. Aside from completion of construction and startup of the LAW Vitrification Facility, the only new capital investments required for starting LAW treatment in Phase 1 are for the TSCR Demonstration Facility adjacent to the AP Tank Farm for pretreatment of the LAW feed from the Southeast (SE) Quadrant DSTs and for modifications to the ETF to allow treatment of the process condensate from the WTP EMF.

The LAW to be pretreated in the AP TSCR/TFPT includes supernate currently in storage in other DSTs in the SE Quadrant of the tank farms and supernate that is retrieved from the SE Quadrant SSTs (A and AX Tank Farms). The SE Quadrant SSTs will be the first tanks retrieved since they are located near the SE Quadrant DSTs and contain a high concentration of long-lived radionuclides.

The LAW and HLW processing facilities that are needed for Phase 1B will be constructed during Phase 1. These new facilities include the SY TSCR and the LILO Station in the West Area[15]. The PFNW facility will also be modified as necessary to increase the treatment capacity of the ICM system before starting Phase 1B operations. Additionally, work will continue to complete the WTV and the HLW Vitrification Facility during Phase 1 to allow HLW treatment to start in 2033.

The process flowsheet for Phase 1 is provided in Figure 1 below. This flowsheet applies to LAW processing operations in Phase 1 from 2021 – 2025. The same LAW processing facilities continue to operate in Phase 1B and Phase 2.

[13] The ACD of December 10, 2020, allows delaying milestones for SST retrievals and for startup of the WTP facilities (including the LAW Vitrification Facility) in accordance with the *force majeure* provisions of the ACD.
[14] Amended Consent Decree between the United States Department of Energy and the State of Washington, ECD No. 59
[15] The LILO Station in West Area is planned to be constructed adjacent to the SY Tank Farm. This facility is referred to as the "SY LILO Station." Similarly, the LILO Station to be constructed near the AP Tank Farm is referred to as the "AP LILO Station."



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DST: Double Shell Tank
EMF: Effluent Management Facility
ETF: Effluent Treatment Facility
HLW: High-Level Waste
IDF: Integrated Disposal Facility
IHS: Interium Hanford Storage
IHLW: Immobilized High-Level Waste
ILAW: Immobilized Low-Activity Waste
IX: Ion Exchange
IXC: Ion Exchange Column
LERF: Liquid Effluent Retention Facility
SE: South Eastern Quadrant
SST: Single Shell Tank
TFPT: Tank Farm Pretreatment Facilities
TSCR: Tank-Side Cesium Removal Facilities
WTP: Waste Treatment & Immobilization Plant

* Solid waste streams with no currently defined treatment or disposal pathway.

Figure 1: Alternative 18 Phase 1 Process Flow

3.1.1 RETRIEVAL OF SE QUADRANT SSTS

Retrieval of the C Tank Farm SSTs was previously completed, and the tanks are in RCRA closure status. The WRPS process model for Alternative 18 shows that retrieval of the SSTs in the A and AX Tank Farms would begin in 2021 and be completed in 2027 as required by the ACD[13, 14]

Since the A and AX Tank Farms are located near the AP Tank Farm, Hose-In-Hose Transfer Lines (HIHTLs) are planned to be used to transfer retrieved waste from the SSTs to a designated DST in the SE Quadrant. The retrieved waste will be transferred as a bulk slurry to the designated DST in the SE Quadrant. After solids/liquid separation, the supernate will be transferred to AP-105 to be sampled and characterized.

3.1.2 LAW CHARACTERIZATION AND STAGING IN SE QUADRANT DSTS

Waste in the SE Quadrant DSTs will be segregated into LAW supernate and HLW slurry by mixing, settling, and decanting in designated DSTs. In Phases 1 and 1B, the LAW supernate streams will be transferred to AP-105 for mixing and sampling to verify compliance with the WTP Waste Acceptance Criteria (WAC)[16]. After the sample results have been evaluated for compliance with the WAC, the characterized LAW will be transferred to AP-107 where it will be staged for delivery to the AP TSCR. Section 2.7 of Appendix A of the AoA Report provides additional details on LAW characterization and staging.

3.1.3 LAW PRETREATMENT IN AP FARM TANK-SIDE CESIUM REMOVAL (TSCR) FACILITY

LAW supernate from AP-107 will be processed in the AP TSCR Facility (also referred to as the TSCR Demonstration Facility) in the same manner as for all other alternatives. These processing operations are described in Section 2.8 of Appendix A of the AoA Report.

The TSCR design includes solids removal by a filtration loop that returns the permeate to AP-107. Cesium is removed from the filtrate in ion-exchange (IX) columns (IXCs). In Phase 1, the cesium depleted LAW is fed to AP-106 where it is staged for delivery to the LAW Vitrification Facility. The AP TSCR also includes an IXC Storage Pad. A more detailed description of the TSCR processes is provided in Section 4.1.5 of this Addendum and in the Low-Activity Waste Pretreatment System Process Information[17].

3.1.4 STAGING PRETREATED LAW IN AP-106

Pretreated LAW supernate from the AP TSCR will be routed to AP-106. In Phase 1 and Phase 1B for Alternative 18, the pretreated LAW in AP-106 will be staged for delivery to the LAW Vitrification Facility.

3.1.5 TRANSFER OF PRETREATED LAW FROM AP-106 TO LAW VITRIFICATION FACILITY

Pretreated LAW from AP-106 will be transferred to one of the LAW Melter Feed Preparation (MFP) Vessels in the LAW Vitrification Facility. The MFP vessels will stage pretreated LAW for treatment in the LAW Vitrification Facility.

3.1.6 VITRIFICATION OF LAW IN LAW VITRIFICATION FACILITY

The LAW vitrification process is the same as that described in Section 2.9 of Appendix A in the AoA Report and in the System Descriptions section of the River Protection Project (RPP) System Plan[18]. Since the LAW Feed Evaporator (LFE) will not be operational in Phases 1 or 1B, the pretreated supernate that is sent to the LAW Vitrification Facility will be relatively dilute (10 percent by weight [wt %]). As a result, the LAW melter efficiency in Phase 1 will be less than in Phase 2 where the LFE will concentrate the feed to 15 wt %. The overall LAW treatment rate of the LAW Vitrification Facility for Phases 1 (and 1B) will therefore also be less than it is in Phase 2.

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[16] WTP Waste Acceptance Criteria (WAC) – HNF-3127, 2015, Liquid Waste Processing Facilities Waste Acceptance Criteria, Rev 7
[17] Addendum C (Process Information for Low-Activity Waste Pretreatment System) to DOE/ORP-2018-02, Rev 2.
[18] River Protection Project System Plan, ORP-11242, Rev 8

3.1.7 DISPOSAL OF ILAW AND SPENT MELTERS IN INTEGRATED DISPOSAL FACILITY

The immobilized LAW (ILAW) produced by the LAW Vitrification Facility will be sent to the IDF for disposal. Spent melters removed from the LAW Vitrification Facility will also be sent to the IDF for disposal. The receipt, off-loading, emplacement, and backfill operations for the ILAW containers and spent LAW melters in the IDF for all phases of Alternative 18 are the same as those described in Section 4.1.6 of this Addendum and in the Facilities Description section of the RPP System Plan[18].

3.1.8 LAW EFFLUENT MANAGEMENT IN WTP EFFLUENT MANAGEMENT FACILITY

Except for the interfaces with the Pretreatment (PT) Facility, the receipt and processing of liquid effluents in the WTP EMF for Alternative 18 will be the same as for Alternative 1 as described in Section 2.1.2 of Appendix A in the AoA Report. For Alternative 18, the PT Facility will not be used, and the LAW Vitrification Facility will transfer liquid effluents directly to the WTP EMF. The concentrate from the EMF evaporator will be returned to the LAW Vitrification Facility to be recycled. The condensate from the EMF evaporator will be transferred to the Liquid Effluent Retention Facility (LERF), where it will be staged for treatment in the ETF.

3.1.9 STAGING AND TREATING PROCESS CONDENSATE AND LEACHATE IN LERF AND ETF

In Phase 1, the process condensate generated by the AY/AZ tank ventilation system, 242-A Evaporator and the WTP EMF, and the leachate collected in the Mixed Waste Burial Trench and from the IDF will be pumped to one of the LERF Basins. The ETF will treat the effluents from the LERF Basins as described in Section 4.1.8 of this Addendum. The treated liquids from the ETF will be sent to the state-approved land disposal site (SALDS) for disposal. The brine from the ETF evaporator will be solidified in a modular grouting system, and the resulting grout containers will be disposed of in the IDF.

The three existing LERF Basins (Basins 42, 43, and 44) segregate the process condensate and leachate and stage feed for delivery to the ETF. Basin 41 construction must be completed for all alternatives to provide the feed stream segregation and storage capabilities needed for starting LAW treatment.

The ETF process configuration includes Main and Secondary Treatment Trains. The Main Treatment Train will remove organics, entrained carbon dioxide, ions, and particulates. The treated feed will be collected in Verification Tanks and transferred to the SALDS. The SALDS is described in Section 11.4 in Appendix B of the AoA Report and in the System Descriptions section of the RPP System Plan[18]. The concentrated liquids from the Main Treatment Train will be sent to an evaporator in the Secondary Treatment Train. In the current ETF design, the evaporator concentrate will be collected in Concentrate Tanks and solidified in a Thin-Film Dryer[19]. The evaporator condensate will be recycled to the Main Treatment Train.

A more complete description of the LERF Basins and the existing ETF is provided in Section 11.1 of Appendix B in the AoA Report and in Section 4.1.8 of this Addendum.

The process condensate generated during Phases 1 and 1B for Alternative 18 contains radionuclides and chemicals that are different from those within the effluents that are currently treated in the existing ETF. An assessment of the ETF flowsheet capabilities for treatment of the process condensate generated by the WTP EMF was completed in 2020[20,21]. The ETF modifications that are in progress to implement the recommendations in the Flowsheet Assessment Report are described in Section 4.1.8 of this Addendum.

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[19] The Thin-Film Dryer does not produce a solidified waste form suitable for disposal. Additionally, the capacity of the Thin-Film Evaporator is inadequate for keeping pace with the rate at which process condensate will be generated once LAW treatment begins. A modular grout system has been proposed to replace the Thin-Film Dryer.

[20] Effluent Treatment Facility Assessment of Flowsheet Impacts from the Hanford Tank Waste Treatment and Immobilization Plant Effluent Management Facility Waste Profile, RPP-RPT-61923, Rev 0

[21] The ETF Assessment of Flowsheet (see previous footnote) concluded that additional administrative controls would be required to limit the radionuclide inventory within the LERF Basins and the ETF.

The WRPS process modeling results for Alternative 18 show that the highest volume of process condensate generated in any given year will be 7.7 million gallons (Mgal) in Phases 1 or 1B, assuming the processing facilities operate at an overall total operating efficiency (TOE) of 40%[22] The leachate production rate is assumed to remain constant at 1.8 Mgal/year. After adjusting the process condensate generation rate to reflect a TOE of 100% and adding the leachate generation rate, the maximum annual volume that the ETF will need to process during Phase 1B is 21.1 Mgal.

Based on the above, the maximum processing rate that the ETF will need to sustain in any year during Phases 1 and 1B is 40.2 gpm. Although this processing rate is below the current ETF design process rate of 100 gpm, the ETF has never sustained a treatment rate of 40 gpm over a year. Since 2012, the ETF has only processed a maximum of 3.9 Mgal in any year (equivalent to a sustained rated of 7.4 gpm).

The AoA team assumed that the facility modifications that will be completed before starting Phase 1 will improve the facility availability, and the as-modified ETF will have adequate capacity to support Phase 1 (and 1B).

3.2 Phase 1B Process Descriptions

In Phase 1B (beginning in 2025), LAW pretreatment and treatment of the LAW from the SE Quadrant DSTs will continue as described in Section 3.1 of this Addendum. LAW processing will begin in West Area in 2026 using off-site commercial treatment and disposal facilities. During Phase 1B, HLW treatment will begin once hot commissioning of the HLW Vitrification Facility has been completed in 2033 as specified in the ACD[13, 14] The HLW pretreatment approach is based on the DFHLW concept used for Alternatives 15, 16, and 17 as described in sections 6.1 through 6.3 of Appendix A in the AoA Report.

Retrieval of the SE Quadrant SSTs will be completed early in Phase 1B (2027). When the HLW Vitrification Facility starts up in 2033 as required by the ACD[14], the LAW generated by the HLW processing operations will be added to the SE Quadrant DSTs. The AP TSCR and the LAW Vitrification Facility will continue to process the LAW supernate in the SE Quadrant DSTs for the duration of Phase 1B and Phase 2.

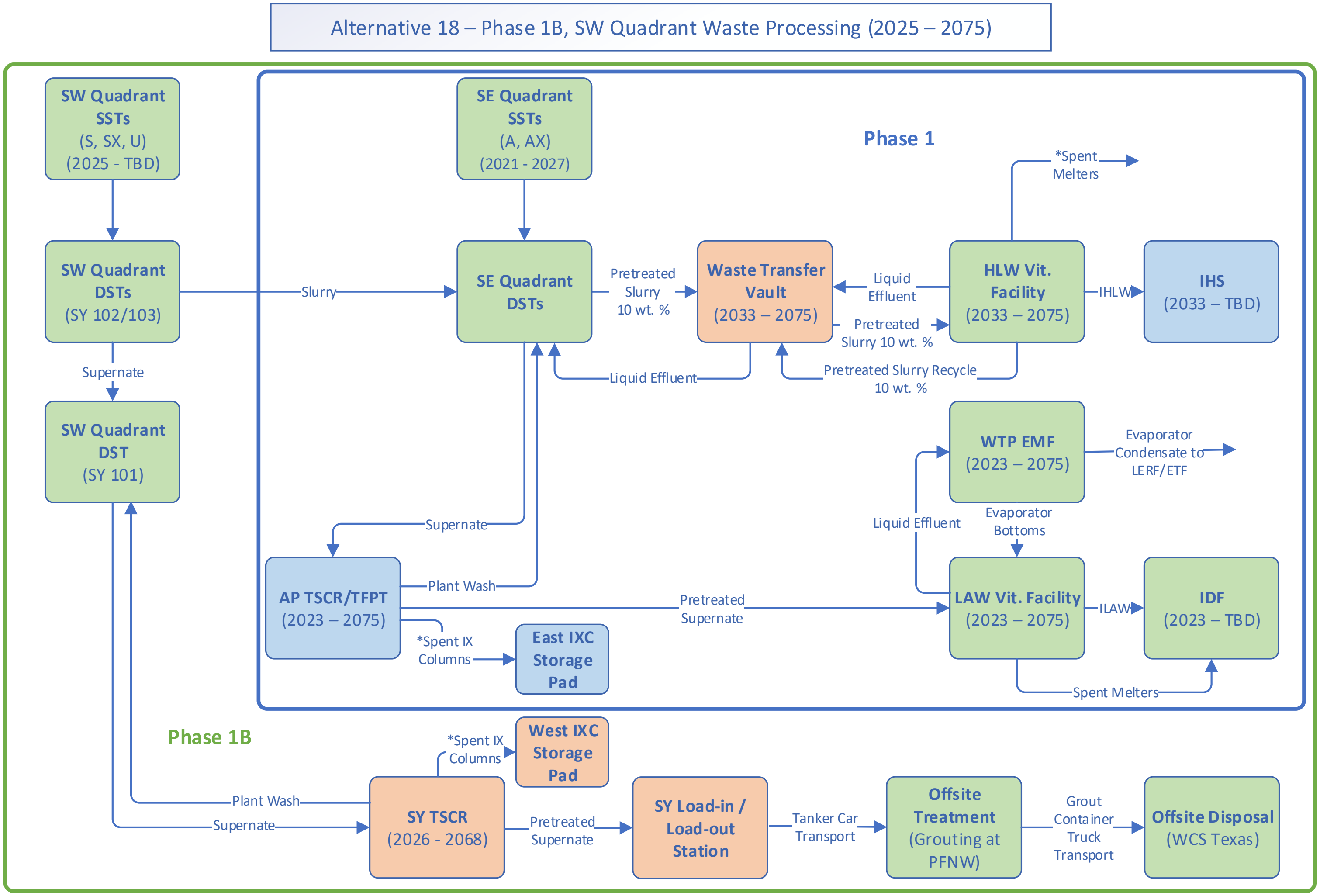
Retrieval of the SW Quadrant SSTs (S, SX, and U Tank Farms) will start at the beginning of Phase 1B. The supernate and sludge slurry will be separated in the SY Tank Farm DSTs. The resultant LAW supernate will be pretreated in the SY TSCR and loaded into tanker trucks in the SY LILO Station. The tanker trucks will deliver pretreated LAW to the off-site PFNW facility in Richland, Washington, to be grouted. After grouting in the PFNW facility (described in Section 4.2.6 of this Addendum), the grout containers will be stored for curing and then loaded onto rail cars to be sent to the Waste Control Specialists, LLC (WCS) facility in Texas for disposal (described in Section 4.2.7 of this Addendum).

During Phase 1B, the LAW and HLW processing facilities that are needed to increase the processing capacity for Phase 2 will be completed. The HLW pretreatment capabilities will be increased by constructing a new HLW Feed Preparation and HLW Feed Preparation and Effluent Management Facility (HFPEM) as described in Section 5.2 of Appendix A of the AoA Report. The LAW treatment capabilities will be increased by constructing a new LFE and a new OSGF. Because of the increased generation rate of process condensate resulting from operation of these new facilities, a new higher capacity ETF will also have to be constructed for Phase 2.

The process flowsheet for Phase 1B is provided in Figure 2.

[22] Updated Waste Treatment and Immobilization Plant Operating Efficiency Estimate, RPP-RPT-61717

PARSONS



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DST: Double Shell Tank
EMF: Effluent Management Facility
ETF: Effluent Treatment Facility
HLW: High-Level Waste
IDF: Integrated Disposal Facility
IHS: Interim Hanford Storage
IHLW: Immobilized High-Level Waste
ILAW: Immobilized Low-Activity Waste
IX: Ion Exchange
IXC: Ion Exchange Column
LERF: Liquid Effluent Retention Facility
SE: South Eastern Quadrant
SST: Single Shell Tank
SW: South Western Quadrant
TFPT: Tank Farm Pretreatment Facilities
TSCR: Tank-Side Cesium Removal Facilities
WCS: Waste Control Specialists
WTP: Waste Treatment & Immobilization Plant

* Solid waste streams with no currently defined treatment or disposal pathway.

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Figure 2: Alternative 18 Phase 1B Process Flowsheet

3.2.1 HLW CHARACTERIZATION AND PRETREATMENT IN SE QUADRANT DSTS

The HLW slurry in the SE Quadrant DSTs will be transferred to AP-101 where it will be sampled and characterized in the same manner as for Alternative 17 as described in Section 8.1 of Appendix A in the AoA Report. For Alternative 18, the HLW pretreatment will be limited to initial solids/liquid separation by settling/decanting followed by solids washing. The washed HLW slurry in AP-101 will be transferred to AP-102, where it will be staged for delivery to the HLW Vitrification Facility via the WTV.

3.2.2 HLW CHARACTERIZATION IN SY-102/103 AND TRANSFER TO SE QUADRANT DSTS

Waste retrieved from the SSTs in the SW Quadrant (S, SX, and U Tank Farms) will be transferred to DST SY-102 (or SY-103). The supernate and sludge will be segregated by settling the waste received in SY-102 (or SY-103). The supernate will be decanted to the 'non-receiving' DST SY-103 (or SY-102) where it will be sampled and characterized. The characterized supernate will be transferred to SY-101 where it will be staged for transfer to the SY TSCR. Once SY-102 and SY-103 reach a combined level of 400 inches of settled solids, the HLW slurry will be transferred to a designated DST in the SE Quadrant via the Cross-Site Transfer System slurry line. HLW characterization will be done in the SE Quadrant DSTs before delivery to the HLW Vitrification Facility (Phase 1B) or to the HFPEM Facility (Phase 2).

3.2.3 TRANSFER PRETREATED HLW FEED FROM SE QUADRANT DSTS TO HLW VITRIFICATION VIA WTV

The HLW slurry in AP-102 will be transferred to the WTV, and ultimately to the HLW Vitrification Facility, in the same manner as for Alternative 17 as described in Section 8.2 of Appendix A in the AoA Report. The WTV will include an HLW Feed Vessel (HFV). In Phase 1B, the HFV will receive batch transfers from AP-102. The HFV contents will be recirculated and diverted to one of the MFP vessels in the HLW Vitrification Facility on an as-needed basis.

An effluent collection vessel in the WTV will receive liquid effluents collected in the Radioactive Liquid Waste Disposal (RLD) system in RLD-VSL-00007/8 in the HLW Vitrification Facility. The effluent collection vessel contents will then be transferred to AP-103.

3.2.4 HLW IMMOBILIZATION IN HLW VITRIFICATION FACILITY

In Phase 1B, hot commissioning of the HLW Vitrification Facility will be completed by 12/31/2033 as required by the ACD[14], and the facility will begin normal operation immediately afterwards. In Phases 1B and 2 of Alternative 18, both HLW melters will ramp up to full capacity according to the ramp-up schedule specified in the Alternative 18 Model Request Form[2].

Since the PT Facility will not be completed or used in Alternative 18, the HLW Vitrification Facility will have to be modified to allow operations independent of the PT Facility. A Melter Assembly Building and a LILO Dock will also be required. These modifications are described in an engineering study in which options for providing these additional capabilities were evaluated[23].

The liquid effluents from the HLW Vitrification Facility will be transferred to an HLW Effluent Collection Vessel in the WTV in the same manner as in Alternative 17 as described in Section 8.3 of Appendix A in the AoA Report. The contents of this vessel will then be transferred to a designated DST in the AP Tank Farm.

3.2.5 STORAGE OF IHLW IN IHS

IHLW canisters that are produced by the HLW Vitrification Facility will accumulate in a buffer storage area within the facility. The IHLW canisters will be loaded into on-site transportation containers (OTCs) which will be transported by a tractor trailer to the IHS as described in Section 2.5 of Appendix A in the AoA Report and in Section 4.2.10 of this

[23] Engineering Study to provide ROM Cost Estimate and Conceptual Development of HLW Options E and F (Equipment Import/Export Routes), 24590-HLW-ES-ENG-15-006, Rev 0

Addendum. The OTC off-loading and storage functions for Alternative 18 are the same as those for Alternative 1 as described in Section 2.5 of Appendix A in the AoA Report.

3.2.6 STORAGE AND DISPOSAL OF SPENT HLW MELTERS

As described in Section 2.6 of Appendix A in the AoA Report, the disposition pathway and required facilities for treatment, storage, or disposal of spent HLW melters has not been determined. The AoA team has assumed that spent HLW melters will be transported to a concrete pad near the IDF for interim storage pending a decision on the disposition pathway.

3.2.7 COMPLETE OF RETRIEVAL OF SE QUADRANT SSTS

The retrieval of the SE Quadrant SSTs (A and AX Tank Farms) will continue in Phase 1B in the same manner as described in Section 3.1.1 in this Addendum. The WRPS Model Results Report[1] shows that retrieval of the SE Quadrant SSTs will be complete early in Phase 1B (2027).

3.2.8 LAW CHARACTERIZATION AND STAGING IN SE QUADRANT DSTS

LAW will be sampled, characterized, and staged in Phase 1B in the same manner as for Phase 1 as described in Section 3.1.2 of this Addendum.

3.2.9 LAW PRETREATMENT IN AP TSCR/TFPT

As discussed in Section 3.1.3 of this Addendum, the capacity and design life of the AP TSCR (TSCR Demonstration Facility) are limited. The AP TSCR will be replaced by a higher capacity TFPT before it exceeds its design life (approximately 3/2028). The AoA team assumed that the TFPT will provide the same particulate and cesium removal performance as the AP TSCR. The TFPT capacity will be 10 gpm.

As an enabling assumption for the risk analysis, the AoA team also assumed that the TFPT technologies will either be the same as those used in the TSCR Demonstration Facility or will have a high enough technology readiness level to allow use without additional technology development and testing. The AoA team assumed that the process functions for the TFPT are the same as those for the AP TSCR as described in Section 3.1.3 of this Addendum. Section 4.1.4 of this Addendum describes the AP TSCR and the TFPT facilities in more detail.

3.2.10 STAGING PRETREATED LAW IN AP-106

As is the case for Phase 1, the pretreated LAW from the AP TSCR/TFPT will be routed to AP-106 where it will be staged for delivery to the LAW Vitrification Facility.

3.2.11 VITRIFICATION OF LAW IN LAW VITRIFICATION FACILITY

The LAW vitrification process operations for Phase 1B are the same as for Phase 1 as described in Section 3.1.6 of this Addendum. In Phase 1B, the LAW Vitrification Facility will receive pretreated LAW from AP-106. This feed will be relatively dilute (10 wt %). Since it will take longer to boil off the excess water in the melters, the melter capacity in Phase 1 and 1B will be less than in Phase 2 where the LFE concentrates the feed to 15 wt %.

3.2.12 DISPOSAL OF ILAW AND SPENT LAW MELTERS IN IDF

The ILAW produced by the LAW Vitrification Facility will be sent to the IDF for disposal. Failed melters removed from the LAW Vitrification Facility will also be sent to the IDF for disposal. Additional information on the IDF is provided in Section 4.1.6 of this Addendum and in Section 2.12 of Appendix A in the AoA Report. The ILAW containers will be off-loaded, emplaced, and backfilled in accordance with IDF facility procedures (to be developed).

3.2.13 LAW EFFLUENT MANAGEMENT IN WTP EMF

As discussed in Section 3.1.8 of this Addendum, the LAW Vitrification Facility transfers liquid effluents directly to the WTP EMF. The concentrate from the EMF evaporators will be returned to the LAW Vitrification Facility to be recycled. The condensate from the EMF evaporators will be transferred to the LERF and will ultimately be treated in the ETF.

3.2.14 RECEIVE AND TREAT PROCESS CONDENSATE AND LEACHATE IN LERF/ETF

As discussed in Section 3.1.9 of this Addendum, an additional LERF Basin will need to be constructed and the existing ETF modified to be able to adequately treat the process condensate generated by the WTP EMF for Phases 1 and 1B. Section 3.1.9 of this Addendum provides an evaluation of the treatment capacity of the existing ETF. This evaluation concluded that the existing ETF, once modified as described in the ETF Flowsheet Assessment[20], will have adequate capacity to treat the process condensate generated in Phases 1 and 1B.

3.2.15 RETRIEVAL OF SW QUADRANT SSTS

The SW Quadrant SSTs (S, SX, and U Tank Farms) will be retrieved immediately after completion of the SE Quadrant SSTs. The retrieval sequence will be prioritized based on highest inventory of Tc-99 and I-129 per retrieved solids volume.

Since the S, SX, and U tank Farms are located near the SY Tank Farm, HIHTLs are planned to be used to transfer the retrieved bulk slurry to SY-102 (or SY-103). The solids and liquids will be separated by settling and decant operations in the receiving DST.

3.2.16 SAMPLE, CHARACTERIZE, AND STAGE LAW AND HLW IN SY-102/103

Supernate will be decanted from the receiving DST SY-102 (or SY-103) to the non-receiving DST SY-103 (or SY-102) where it will be sampled and characterized. The characterized supernate will be transferred to SY-101 where it will be staged for delivery to the SY TSCR.

Once SY-102 and SY-103 reach a combined level of 400 inches of settled solids, the HLW slurry will be transferred to a designated DST in the SE Quadrant via the Cross-Site Transfer System slurry line. HLW will be characterized in SE Quadrant DSTs before delivery to the HLW Vitrification Facility (Phase 1B) or to the HFPEM Facility (Phase 2).

3.2.17 PRETREAT LAW IN SY FARM TSCR

For Phase 1B of Alternative 18, the SY TSCR is assumed to start up by 1/2026. This is several years after startup of the AP TSCR (TSCR Demonstration Facility). Given this timeline, the AoA team assumed that the SY TSCR would have the same internal functionality and basic design architecture as the AP TSCR (TSCR Demonstration Facility). The internal process flow for the SY TSCR is assumed to be the same as the AP TSCR as described in Section 3.1.3 of this Addendum and in the Process Information Addendum for the Low-Activity Waste Pretreatment System[17]. Similarly, the general design architecture for the SY TSCR is assumed be the same as for the AP TSCR as described in Section 4.1.4 of this Addendum.

The principal differences between the AP and SY TSCRs is that the SY TSCR receives LAW feed from SY-101 and must then store the pretreated LAW for the time required for the tanker truck in the SY LILO Station to be filled and delivered to the PFNW facility. Additionally, the interfaces with the DSTs and Tank Farm infrastructure for the SY Tank Farm are different from those in the AP Tank Farm. For purposes of this Addendum, the AoA team assumed that the scope of the DST and waste transfer system modifications that will be required for installation of the SY TSCR are similar to modifications required for installation of the AP TSCR.

3.2.18 TRANSFER PRETREATED LAW FROM SY TSCR TO TANKER TRUCK IN SY LILO STATION

Since the SY LILO Station is a proposed new facility, it does not have an established design basis. The process functions are assumed to be the similar to those for the AP LILO Station as described in the AP LILO Station Functional

Requirements Specification[24] . The design drawings for the AP LILO Station show the design architecture to accomplish these functions.

The functionality of the SY LILO Station is different from the AP LILO Station in that the pretreated LAW from the SY TSCR will not be staged in one of the SY DSTs as is the case for the AP TSCR. Because the pretreated LAW cannot be staged in a DST, the SY TSCR or the SY LILO Station will need to include surge/staging vessels. The SY LILO facility is described in more detail in Section 4.2.5 of this Addendum.

The process functions required for the SY LILO Station are listed below.

- Stage pretreated LAW from the SY TSCR in a surge/staging vessel(s)
- Receive empty tanker truck in LILO Station pad and weather enclosure
- Connect tanker to HIHTLs and ventilation pipe
- Pump pretreated LAW from staging vessels to tanker via HIHTLs
- Ventilate tanker to SY ventilation system during filling operations
- Drain and flush HIHTLs
- Monitor waste transfer and flushing operations
- Disconnect tanker from HIHTLs
- Remove tanker truck from LILO Station pad and weather enclosure

3.2.19 TRANSPORT PRETREATED LAW FROM SY LILO FACILITY TO PFNW FACILITY VIA TANKER TRUCK

Tanker trucks will be transported over existing roads between the SY Tank Farm complex and the PFNW Facility. Depending on the efficacy of the TFPT in removal of strontium, the pretreated LAW will be classified as Class A or B mixed low-level waste (MLLW) for disposal purposes. The sampling, analysis and transportation requirements for liquid MLLW are the same as those described in Section 3.2.23 of this Addendum.

3.2.20 OFF-LOAD PRETREATED LAW FROM TANKER TRUCK AT PFNW FACILITY

Tanker trucks will be inspected and surveyed outside the access gate to the Mixed Waste Facility (MWF) within the PFNW facility complex. Assuming that the tanker truck is accepted, it will enter the Radiological Control Area. The tanker truck will then be off-loaded in the truck loading area.

3.2.21 GROUTING LAW IN PFNW FACILITY

In Phase 1B, the PFNW facility in Richland, Washington, will be used to treat pretreated LAW supernate from the West Area Tank Farms. The pretreated LAW will be loaded into a tanker truck in the SY LILO Station and will be transported over the road to the PFNW facility. The received LAW supernate (liquid) will be treated by grouting in one or more ICM process lines within the Stabilization Building (STB) that is part of the PFNW facility complex. The PFNW facility, including the STB and ICM system, are described in more detail in Section 4.2.6 of this Addendum. The ICM process functions are as follows:

- Reagent storage
- Reagent weighing and metering
- Off-loading tanker truck and pumping liquid LAW to the ICM grout container
- Mixing reagents and liquid LAW in the ICM grout container
- Sampling filled grout container
- Storage of filled grout containers until cure time requirement is satisfied
- Loading grout containers into shipping containers (if required)
- Loading shipping containers into railcars for shipment to the WCS facility

Reagents are stored in silos and are weighed, metered, and gravity fed to the grout container. The reagents are added in parallel with pumping of liquid LAW into the grout container. The grout solution will be mixed by a hand-held mixer that is

[24] AP Farm Truck Load-In/Load-Out Station Functional Requirements Specification, RPP-SPEC-63477, Rev 2

moved vertically and laterally during mixing operations to achieve a homogenous slurry. After the mixing operations have been completed, the grout container will be surveyed for external contamination, decontaminated if required, and then moved to the containerized storage area to allow the grout to cure.

The ICM process will involve filling and mixing grout slurry in a 55-gallon drum. Depending on the required treatment rate, larger grout containers can be used. As discussed in Section 4.2.6.4 of this Addendum, the ICM capacity must be increased by a factor of five to keep pace with the rate at which pretreated LAW will be produced by the SY TSCR. The ICM capacity could be increased by using larger grout containers and/or adding parallel ICM process lines.

The ICM Room and other process areas within the STB will be maintained at a negative pressure by the STB Confinement System. The confinement ventilation exhaust will be filtered through two banks of HEPA[25]/charcoal filters. The filtered air will be exhausted through the ventilation exhaust stacks by two exhaust fans.

A separate STB Process Vent System will maintain process enclosures at a negative pressure with respect to the process rooms. Vapors from the ventilation lid that will be placed over the grout container during fill operations in the ICM system will be ventilated to this separate vent system. The STB Process Vent System will include particulate and carbon filters in series.

3.2.22 TRANSPORT GROUT CONTAINERS TO WASTE CONTROL SPECIALIST FACILITY

The waste packaging requirements for disposal vary based on the radionuclide content of the grout mixtures (refer to 49 Code of Federal Regulations [CFR] Part 173). The grout containers will be sampled and analyzed in accordance with a Sampling and Analysis Plan to verify the radionuclide content.

The waste will be classified as Class A, B, or C, or Greater than Class C waste depending on the sample analysis results. Based on the expected concentration of radionuclides present in the pretreated LAW feed, the waste classification is expected to be Class C. The sample analysis results will also be compared to the expected “waste profile” and to the WAC for WCS to verify that the waste is suitable for disposal.

At least 5 days before shipment, the Department of Energy (DOE) will provide WCS with a draft Uniform Low-Level Radioactive Waste Manifest (Manifest) and a Shipment Request. Once enough grout containers have met the cure time requirements, they will be loaded into an appropriate packaging container (e.g., B-12, B-16, B-25, or equivalent) in accordance with the packaging requirements applicable to the waste classification.

The waste packages will be loaded onto a rail car in the rail loading area within the PFNW facility complex. The rail car will be surveyed to verify that no external contamination is present. Once the rail car has been loaded, and the waste manifest has been completed, the shipment will be released.

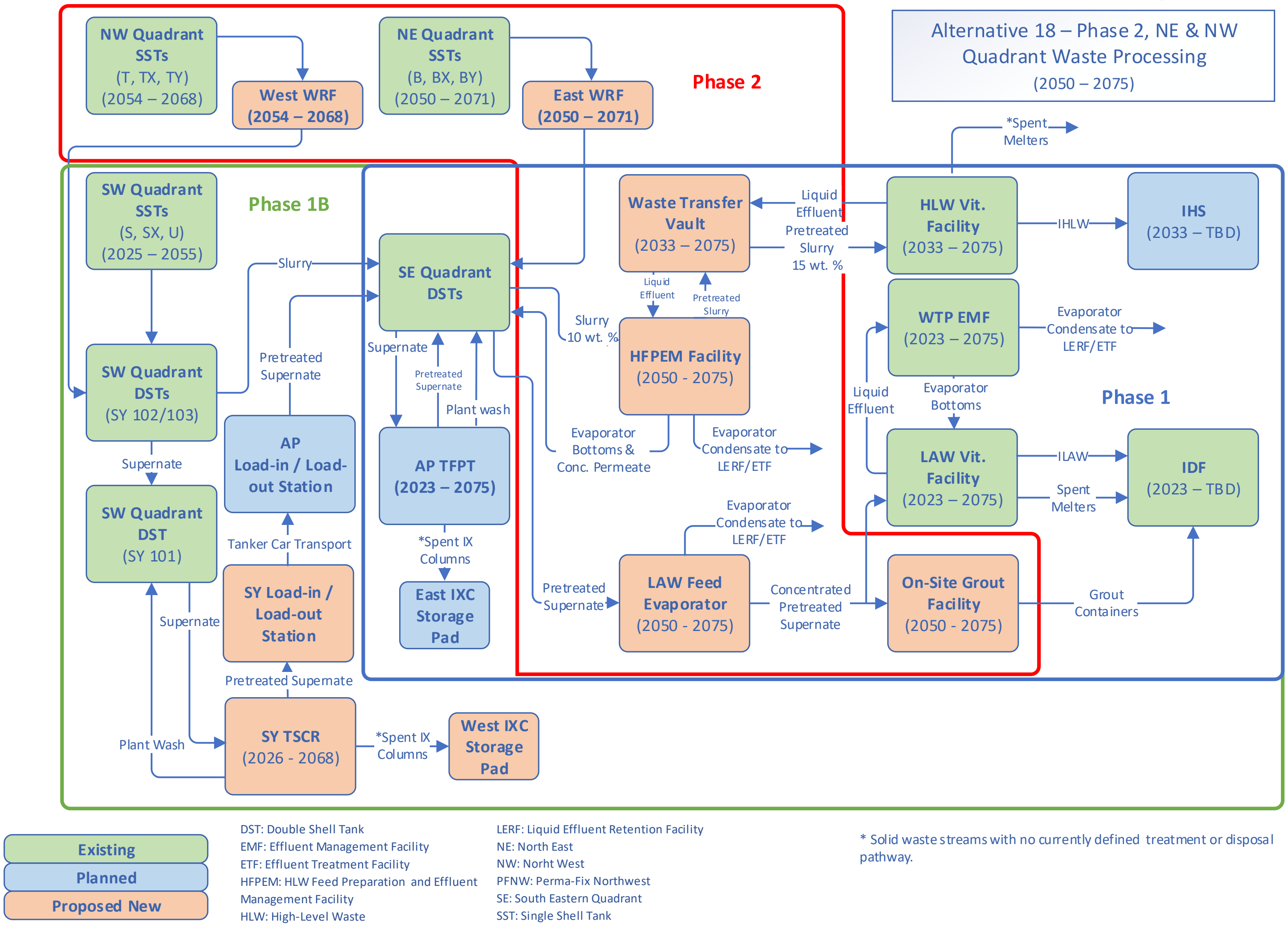
3.2.23 DISPOSAL OF GROUT CONTAINERS AT WCS FACILITY

WCS operators will inspect, survey, and off-load and dispose of the waste packages at the WCS facility in accordance with established facility operating procedures.

3.3 Phase 2 Process Descriptions

In Phase 2, the processing rate for HLW and LAW will increase significantly with completion of new higher capacity pretreatment and treatment facilities. The new facilities to be constructed in the latter part of Phase 1B include the HFPEM Facility, the AP LILO Station, the LFE, and the OSGF. Phase 1 and 1B facilities continue to operate, with the exception of off-site grout treatment. Additionally, a new higher capacity ETF will also be required. The process flowsheet for Phase 2 is provided in Figure 3 below.

[25] HEPA – High efficiency particulate air



DST: Double Shell Tank
EMF: Effluent Management Facility
ETF: Effluent Treatment Facility
HFPEM: HLW Feed Preparation and Effluent Management Facility
HLW: High-Level Waste
IDF: Integrated Disposal Facility
IHLW: Immobilized High-Level Waste
IHS: Hanford Interim Storage
ILAW: Immobilized Low-Activity Waste
IX: Ion Exchange
IXC: Ion Exchange Column
LERF: Liquid Effluent Retention Facility
NE: North East
NW: Norht West
PFNW: Perma-Fix Northwest
SE: South Eastern Quadrant
SST: Single Shell Tank
SW: South Western Quadrant
TFPT: Tank Farm Pretreatment Facilities
TSCR: Tank-Side Cesium Removal Facilities
WCS: Waste Control Specialists
WRF: Waste Retrieval Facility
WTP: Waste Treatment and Immobilization Plant

* Solid waste streams with no currently defined treatment or disposal pathway.

03-31-2021, Rev. 9

Figure 3: Alternative 18 Phase 2 Process Flowsheet

3.3.1 RETRIEVAL OF NE QUADRANT SSTS

The NE Quadrant SSTs include the SSTs in the B, BX, and BY Tank Farms (referred to as “B complex”). These tank farms are located too far away from the SY Tank Farm to make HIHTLs practicable for transferring the retrieved waste using above-ground HIHTLs. The East Area WRF will provide new waste storage tanks and below-grade pipe-in-pipe waste transfer lines to connect between the B complex and the WRF and between the WRF and the appropriate DST tank farm in the SE Quadrant.

Retrieval of the SSTs in the B complex starts in 2050, which is coincident with the start of operations in the higher capacity LAW treatment and HLW pretreatment facilities. As discussed in Rev 2 of the Model Results Report[1], retrieval of the B complex SSTs will continue until 2071, which is 5 years before completion of tank waste treatment for Alternative 18.

3.3.2 RECEIPT, STORAGE, AND TRANSFER OF BULK SLURRY FROM NE QUADRANT SSTS IN EAST AREA WRF

As described in the Mission Analysis Report for the East Area WRF[26], the preconceptual design includes new intermediary holding tanks/vessels and pipe-in-pipe waste transfer lines and associated infrastructure to facilitate retrieval of the B complex SSTs and transfer of the bulk slurry to a designated DST in the SE Quadrant. Sections 4.3.2 and 4.3.8 of this Addendum and the Facility Descriptions section of the RPP System Plan[18] provide more details on preconceptual design of the East and West Area WRFs.

3.3.3 TRANSFER BULK SLURRY FROM EAST AREA WRF TO DST IN SE QUADRANT

The bulk slurry in the East Area WRF tanks/vessels will be transferred to a designated DST(s) within the SE Quadrant for solids/liquid separation. New pipe-in-pipe waste transfer and the associated waste transfer infrastructure installed as part of the East Area WRF project will be used to transfer the bulk slurry from the East Area WRF to a designated tank farm or DST(s) within the SE Quadrant.

3.3.4 HLW SAMPLING, CHARACTERIZATIOIN, AND STAGING IN SE QUADRANT DSTS

In Phase 2 the HLW pretreatment capacity increases significantly with the addition of the new HFPEM Facility. This increased pretreatment capacity will require that multiple DSTs in the SE Quadrant provide HLW sampling, characterization, and staging functions.

In addition to AP-105, other DSTs in the SE Quadrant need to be designated for HLW feed sampling and characterization in Phase 2. It is also expected that, in addition to AP-102, other DSTs in the SE Quadrant will need to be designated to stage characterized HLW feed for delivery to the HFPEM Facility in Phase 2.

3.3.5 TRANSFER PRETREATED HLW FEED FROM SE QUADRANT DST TANK FARMS TO HFPEM FACILITY

HLW slurry will be transferred in batches from the designated HLW feed staging DSTs in the SE Quadrant to the HFPEM Facility for pretreatment. The HLW feed will be received in one of the HLW Feed Preparation Vessels (HFPVs) within the HFPEM Facility.

3.3.6 PRETREAT HLW IN HFPEM FACILITY

In Alternative 18, the HFPEM Facility will provide the same pretreatment functions as for Alternative 14 as described in Section 5.2 of Appendix A in the AoA Report. These process functions include solid/liquid separation, caustic leaching, washing, and feed concentration and are accomplished by using vessel mixing, decanting, and chemical additions.

The HFPEM Facility also provides the same filtration capability as Alternatives 14. Filtration loops with cross-flow filters are used to concentrate the decanted liquids from the HLW pretreatment processes. The concentrate from the filtration

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[26] Mission Analysis Report Waste Feed Delivery Projects East Area Waste Retrieval Facility, RPP-RPT-44860 dated 3/18/2010

loop will be blended with the concentrated pretreated HLW in the HFPVs in one of the HFVs. The permeate from the filtration loop will be sent to the HLW Evaporator (also located within the HFPEM Facility).

The process functions for the HFPEM Facility for Alternative 18 are the same as for Alternative 14 which are described in Section 5.2 of Appendix A in the AoA Report. Since the boil-off rate (capacity) of the HLW evaporator within the HFPEM Facility for Alternative 18 will be different from Alternative 14, the size and configuration of the facility are slightly different. The facility size and configuration for the HFPEM Facility for Alternative 18 is described in more detail in Section 4.3.3 of this Addendum.

3.3.7 TRANSFER CONCENTRATED PRETREATED HLW FROM HFPEM FACILITY TO HLW VITRIFICATION FACILITY

The concentrated pretreated HLW in the HFV will be transferred to the HLW Vitrification Facility by routing through the WTV. This waste transfer process from the HFPEM Facility to the WTV and from the WTV to the HLW Vitrification Facility is the same as for Alternative 17 as described in Section 8.2 of Appendix A in the AoA Report. For Alternative 18, the HFVs in the HFPEM Facility stage the concentrated pretreated HLW. The HFV contents are recirculated through a small HFV in the WTV. The HLW in this recirculation loop will be diverted to one of the MFP Vessels within the HLW Vitrification Facility on an as needed basis.

3.3.8 HLW IMMOBILIZATION IN HLW VITRIFICATION FACILITY

The processes for vitrifying the HLW feed received from the HFPEM Facility will be the same as described in Section 2.3 of Appendix A in the AoA Report. Although the internal vitrification process will be the same for all alternatives, including Alternative 18, the liquid effluents from the HLW Vitrification Facility will be processed differently.

In Alternative 18, the liquid effluents from the HLW Vitrification Facility will be collected in RLD-VSL-00008 and pumped or gravity fed to a small Effluent Collection Vessel in the WTV. This collection vessel will then be transferred to the HFPEM Facility. The HLW Evaporator Feed Vessels within the HFPEM Facility will stage the liquid effluents for delivery to the HLW Evaporator.

3.3.9 STORAGE OF IHLW IN IHS

The IHLW canisters produced by the HLW Vitrification Facility will be of the same form and generally have the same chemical and radionuclide concentrations as for all other alternatives. Because of the constrained LAW processing rate in Phase 1B, approximately 25 % more IHLW canisters will be produced in Alternative 18 than in Alternative 14.

The larger number of IHLW canisters produced in Alternative 18 should not require a change in the capacity requirement for the IHS. As described in the IHS Conceptual Design Report[27], the IHS will have two storage vaults with a capacity of 2,016 each. The IHS conceptual design also specifies that additional storage vaults could be constructed later if necessary.

As indicated in Section 3.2 of the AoA Report, ORP directed the AoA team to assume that the Off-Site Geological Repository would be ready to receive IHLW canisters at the end of calendar year (CY) 2034. Since this is only one year after the startup of the HLW Vitrification Facility, the IHS capacity as it is currently designed, was determined by the AoA team to be more than adequate. If the Off-Site Geological Repository is not available to receive IHLW canisters in 2034, the capacity could be increased by constructing additional storage vaults for the IHS.

3.3.10 STORAGE AND DISPOSAL OF SPENT HLW MELTERS

As described in Section 2.6 of Appendix A in the AoA Report, the alternatives for storage and final disposition of spent HLW melters have not been evaluated. For purposes of the AoA, the AoA team assumed that spent HLW melters will be transported to a concrete pad for interim storage pending a decision on the disposition pathway.

[27] Interim Hanford Storage Conceptual Design Report, RPP-RPT-52176 dated 6/12/2012

3.3.11 HLW EFFLUENT MANAGEMENT IN HFPEM FACILITY

The HLW Evaporator in the HFPEM Facility will concentrate the liquid effluents from the HLW Vitrification Facility and the permeate from the cross-flow filtration loop that is part of the pretreatment process within the HFPEM Facility. The liquid effluent from the HLW Vitrification Facility will be transferred to one of the evaporator feed vessels in the HFPEM Facility in the manner described in Section 3.3.8 of this Addendum. The bottoms from the evaporator will be collected in one of the evaporator concentrate vessels, and the condensate will be pumped to the LERF/ETF in a continuous feed mode.

The required boil-off capacity for the HLW Evaporator for Alternative 18 is 9.7 gpm. In contrast, the boil-off capacity for the HLW Evaporator for Alternative 2 is 13.3 gpm. With minor adjustment to building sizing to account for the differences in capacity, the preconceptual design developed for the HLW Evaporator for Alternative 2 is generally applicable for Alternative 18. The size and configuration of the LFE for Alternative 18 is described in more detail in Section 4.3.4 of this Addendum.

3.3.12 LAW CHARACTERIZATION AND STAGING IN SE QUADRANT DSTS

In Phase 2, LAW in the SE Quadrant DSTs is sampled, characterized, and staged in the same manner as in Phases 1 and 1B as described in Section 3.1.2 of this Addendum. In Phase 2, the LAW treatment capacity increases significantly with the addition of the new OSGF. As a result, multiple DSTs within the SE Quadrant will need to be designated for sampling and characterizing LAW feed. Once characterized, LAW feed will be staged in AP-107 for delivery to the AP TFPT.

3.3.13 LAW PRETREATMENT IN AP TFPT

The AP TFPT for Phase 2 is assumed use of the same technology and design basis as the Phase AP TFPT to be placed in service for Phase 1B. The Phase 1B AP TFPT is described in Section 3.2.9 of this Addendum. The only difference between the Phase 1B TFPT and the Phase 2 TFPT is in the pretreatment capacity. The TFPT capacity will have to increase from 10 gpm to 20 gpm in Phase 2 to keep pace with the increase in the LAW treatment rate provided by the OSGF. It is assumed that the Phase 1B TFPT will be designed to be able to add components or modules to increase capacity.

3.3.14 STAGING PRETREATED LAW IN AP-106

As was the case for Phases 1 and 1B, the pretreated LAW from the AP TSCR will be routed directly to AP-106. In Phase 2, the pretreated LAW in AP-106 will be transferred to the LFE to be concentrated before it is sent to the LAW Vitrification Facility to be vitrified.

3.3.15 CONCENTRATION OF PRETREATED LAW IN LFE

The LFE concentrates pretreated LAW from AP-106. The LFE process functions for Alternative 18 are the same as for Alternative 2. Pretreated LAW will be transferred from AP-106 to the LFE in a continuous feed mode. The evaporator bottoms will be collected in one of the concentrate vessels in the LFE. The LAW evaporator will concentrate the pretreated LAW feed, and the concentrated LAW will be collected in one of the concentrates vessels within the LFE Facility. The LAW within the concentrates vessel will be sampled, characterized, and then transferred to one of the MFP vessels in the LAW Vitrification Facility or to one of the concentrates receipt vessels in the OSGF. The condensate from the LFE evaporator will be transferred to LERF/ETF in a continuous feed mode. The LFE process functions are described in detail in Section 3.9 of Appendix A in the AoA Report.

The Model Results Report[1] indicates that the required boil-off rate (capacity) for the LFE will have to be at least 9.6 gpm to enable LAW processing to keep pace with HLW processing in Phase 2. Other than resizing the facility based on the differences in capacity, the basic design for the Alternative 18 LFE is the same as the Alternative 2 LFE. The preconceptual design for the LFE facility for Alternative 18 is described in Section 4.3.4 of this Addendum.

3.3.16 VITRIFICATION OF LAW IN LAW VITRIFICATION FACILITY

The LAW Vitrification Facility will process pretreated feed in the same way as described for Phase 1 in Section 3.1.6 of this Addendum. Additional details on the LAW Vitrification Facility processes and design features are provided in Section 2.9 of Appendix A in the AoA Report and in the Facility Descriptions section of the RPP System Plan[18].

In Phase 2, the LAW feed source and the concentration of the feed will be different from those for Phases 1 and 1B. The LAW feed source for Phase 2 will be from one of the evaporator concentrates vessels in the LFE. Concentrated pretreated LAW from these vessels will be transferred to one of the MFP vessels in the LAW Vitrification Facility as needed. The LAW sent to the MFP vessels in Phase 2 will be concentrated to 15 wt %, whereas the feed sent directly from AP-102 in Phases 1 and 1B will be limited to 10 wt %. Because of the higher feed concentration, the LAW melters will operate at a higher efficiency in Phase 2.

3.3.17 DISPOSAL OF ILAW AND SPENT LAW MELTERS IN IDF

As in the case of Phases 1 and 1B, the ILAW produced by the LAW Vitrification Facility will be sent to the IDF for disposal in Phase 2. Failed melters removed from the LAW Vitrification Facility will also be sent to the IDF for disposal. Additional information on the IDF is provided in Section 4.1.6 of this Addendum, in the IDF Facility Data[28], and in the IDF Performance Assessment[29].

As discussed in Section 4.1.6 of this Addendum, the volume of grout generated by the OSGF in Phase 2 for Alternative 18 will exceed the capacity of the IDF. The additional volume of ILAW glass, and to a lesser extent, the volume of the spent LAW melter overpacks, will compound the IDF capacity problem. The AoA team did not evaluate the technical feasibility or cost implications of expanding the IDF or implementing other options for on-site or off-site disposal of grouted LAW.

3.3.18 LAW EFFLUENT MANAGEMENT IN WTP EMF

As discussed in Section 3.1.8 of this addendum, the LAW Vitrification Facility will transfer liquid effluents directly to the WTP EMF. The concentrate from the EMF evaporators will be returned to the LAW Vitrification Facility to be recycled. The condensate from the EMF evaporators will be transferred to the LERF and ultimately treated in the ETF.

3.3.19 TREAT PROCESS CONDENSATE AND LEACHATE IN ETF

As discussed in Section 4.1.8 of this Addendum, the capacity of the existing ETF for Alternative 18 is not adequate to keep pace with the process condensate that will be generated in Phase 2. Given that the ETF treatment rate (capacity) would have to increase by over 50%, the AoA team determined that the existing ETF could not be modified to achieve such a large increase in capacity and that the existing ETF would have to be replaced with a newer higher capacity ETF prior to starting Phase 2.

In addition to the need to provide a much higher treatment capacity for Phase 2, the new ETF will also have to be designed to be able to treat the process condensate generated by the HLW Evaporator within the HFPEM Facility. The chemical and radionuclide concentrations of the evaporator condensate from the HLW Evaporator would likely be different than the evaporator condensate from the WTP EMF. A flowsheet assessment similar to that performed for the process condensate from the WTP EMF[20] would be required to determine the treatment capabilities required for the new ETF for Phase 2.

3.3.20 COMPLETE RETRIEVAL OF SW QUADRANT SSTS

The WRPS process model predicts that retrieval of the SSTs in the SW Quadrant will be completed in 2055. At that time, retrievals will start in the SSTs in the NW Quadrant.

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[28] Facility Data for Hanford Integrated Disposal Facility Performance Assessment, RPP-20691, Rev 1
[29] Performance Assessment for the Integrated Disposal Facility, RPP-RPT-59958, Rev 1A

3.3.21 RETRIEVAL OF NW QUADRANT SSTS

The NW Quadrant SSTs include the SSTs in the T, TX, and TY Tank Farms (referred to as "T complex"). These tank farms are located too far away from the SY Tank Farm to make HIHTLs practicable for transferring the waste received. The West Area WRF will provide new waste storage tanks and pipe-in-pipe waste transfer lines to connect between the T complex and the WRF and between the WRF and SY Tank Farm.

As was the case for Phases 1 and 1B, the retrievals will be sequenced by tank farms and by individual SSTs within the tank farms to prioritize retrieval of the highest risk tanks first. Retrieval of the SSTs in T complex will start in 2055, which is coincident with completion of the SST retrievals in the SW Quadrant. Retrieval of the T complex SSTs will continue until 2068, which is seven years prior to mission completion for Phase 2.

3.3.22 RECEIPT, STORAGE, AND TRANSFER OF BULK SLURRY FROM NW QUADRANT SSTS IN WEST AREA WRF

Retrieval of the SSTs in the T complex will require a WRF in the West Area to provide the storage and waste transfer infrastructure required to transfer the retrieval bulk slurry to the ST Tank Farm DSTs. Although the preconceptual design for the West Area WRF is not specifically described in the Mission Analysis Report for the East Area WRF[26], the AoA team has assumed that the West Area WRF would have the same functions and capabilities as the East Area WRF, including new intermediary holding tanks/vessels, pipe-in-pipe waste transfer lines, and associated infrastructure to facilitate retrieval of the T complex SSTs and transfer of the bulk slurry to SY-102 or SY-103. The East and West WRFs are described in more detail in Sections 4.3.2 and 4.3.8 of this Addendum and in the Facilities Descriptions section of the RPP System Plan[18].

3.3.23 TRANSFER BULK SLURRY FROM WEST AREA WRF TO SY-102/103

The bulk slurry in the West Area WRF tanks/vessels is transferred to either SY-102 or SY-103 for solids/liquid separation. New pipe-in-pipe waste transfer lines and the associated waste transfer infrastructure installed as part of the West Area WRF project will be used to transfer the bulk slurry from the East Area WRF to the SY Tank Farm.

3.3.24 SAMPLING, CHARACTERIZATION, AND STAGING LAW AND HLW IN SY-102/103

Bulk slurry retrieved from the T complex SSTs will be received in either SY-102 or SY-103. The solid/liquid separation and sampling and characterization processes that will occur in SY-102/103 will be the same as for Phase 1B as described in Section 3.2.16 of this Addendum. The characterized LAW supernate will be transferred to SY-101 where it will be staged for delivery to the SY TSCR. Once the combined level of solids in SY-102 and SY-103reaches 400 inches, the contents will be mixed, sampled, and characterized. The characterized HLW slurry will then be transferred to a designated DST in the SE Quadrant.

3.3.25 TRANSFER HLW FROM SY-102/103 TO SE QUADRANT DSTS

The characterized HLW slurry in SY-102 or SY-103 will be transferred to a designated DST in the SE Quadrant via the Cross-Site Transfer System slurry line.

3.3.26 STAGE LAW IN SY-101

LAW supernate will be sampled and characterized in SY-102/103 prior to transfer to SY-101. The characterized LAW supernate in SY-101 will be staged for delivery to the SY TSCR.

3.3.27 PRETREAT LAW IN SY FARM TSCR

For Phase 2, the LAW in SY-107 will be pretreated in the SY TSCR in the same manner as for Phase 1B as described in Section 3.2.17 of this Addendum.

3.3.28 TRANSPORT PRETREATED LAW FROM SY FARM LILO FACILITY TO AP LILO STATION VIA TANKER CAR

Filled tanker trucks will transport pretreated LAW over existing roadways from the SY Tank Farm to the AP Tank Farm. Since these roads are restricted and the there is no transfer of custody involved, it is assumed that no additional sampling and analysis, waste manifests, and transportation plans are required.

3.3.29 OFF-LOAD PRETREATED LAW FROM TANKER CAR IN AP LILO STATION TO AP-106

The AP LILO Station will provide the means to receive and off-load from tanker trucks pretreated LAW from the SY LILO Station so that it can be staged for concentration in the LFE and ultimately grouted in the OSGF.

The process functions for the AP LILO Station are described in the AP LILO Functional Requirements Specification[24]. The primary difference between the SY LILO Station described in Section 3.2.18 of this Addendum and the AP LILO Station is that the scope of AP LILO Station project includes the necessary tank farm infrastructure to transfer the pretreated LAW from a tanker truck to a DST (AP-101). The AP LILO Station elements include pumps, pump pits, jumpers, valve manifolds, pipe-in-pipe transfer lines, and an associated monitoring and control system. Since the SY LILO Station will interface directly with the SY TSCR, the scope of the SY LILO Station presumably will not include new infrastructure within the SY Tank Farm.

3.3.30 GROUT LAW IN OSGF

The OSGF will be a new facility required for treatment of LAW in Phase 2. The supplemental LAW that would otherwise need to be vitrified in new melter-based facilities will be grouted in this facility. In addition, the OSGF would also grout the pretreated LAW produced by the SY TSCR. The objective in using grout for treatment of these LAW streams is to reduce the capital and operating costs for LAW treatment. Grouting the LAW on site would also enable disposing of the grout containers on site at the IDF, thereby reducing transportation and waste disposal costs.

Since the OSGF is a proposed new facility and does not have a formal design basis, the AoA team developed a notional design basis to serve in providing a cost estimating basis and to assess the project and operational risks and opportunities. The following subsections describe the technologies, process functions, and equipment configuration that the AoA team assumed for the OSGF. Section 4.3.5 of this Addendum describes the process facility sizing and high-level process and facility structures, systems, and components (SSCs) that were assumed for the OSGF.

3.3.30.1 Grouting Technology Selection

Several different grouting technologies have been developed for encapsulation of dangerous and radioactive wastes. The selection of the grouting technology depends on the composition of the concentrations of the chemical and radioactive constituents of the waste feed. The basic process steps are similar for all grout technologies, but the grout formulations differ, and the process equipment for blending, mixing, and container filling is tailored to the grout formulation. Several alternative analyses and value engineering (VE) studies were performed for grouting liquid LAW and effluents resulting from processing tank waste at the Hanford Site.

As part of the Secondary Liquid Waste Treatment (SLWT) project, Pacific Northwest National Laboratory tested three waste forms (cast stone, Ceramicrete, and DuraLith) for treatment of liquid effluents in the ETF. A technology readiness assessment (TRA) was performed for the three waste form technologies[30]. A VE study was then performed to select the preferred waste form. As documented in the VE study[31], cast stone was selected as the preferred waste form for treating the liquid effluents from tank farm and WTP facilities.

Grouting technologies were recently evaluated in an Analysis of Approaches for Supplemental Treatment of LAW at the Hanford Site[32]. Based primarily on the fact that cast stone is similar to the saltstone waste form, which has been used

[30] Preliminary Technology Readiness Assessment of DuraLith, Cast Stone, and Ceramicrete Immobilization of WTP Secondary Liquid Waste, RPP-ASMT-50873

[31] Value Engineering Report for Secondary Liquid Waste Treatment Project, 2012, RPP-RPT-51127, Rev 0

[32] Report of Analysis of Approaches to Supplemental Treatment of Low-Activity Waste at the Hanford Nuclear Reservation, SRNL-RP-2018-00687

successfully at the Savannah River Site (SRS) since 1991, cast stone was selected as the preferred grout technology for the supplemental LAW alternative analysis for the Hanford Site.

For disposal of grouted LAW at the IDF, the preferred grout technology will require additional technology development testing to demonstrate that technetium, iodine, and nitrate can be adequately retained within the grout matrix. The recent testing of grout performance for retention of technetium and iodine is summarized in the Analysis of Approaches for Supplemental Treatment of LAW at the Hanford Site[32]. A new performance assessment will have to be performed to confirm that grouted LAW can meet the long-term performance objectives of the IDF.

The LFE concentrates the pretreated LAW that will be staged in AP-101 for delivery to the OSG. Since the LFE has not been designed, the characteristics of the feed to the OSGF are not known. Once the LFE design has been progressed, a trade study should be performed to verify that cast stone is the best grout form to use. A trade study could also determine the appropriate process line equipment, configuration, and sizing for the OSGF.

As described in Section 3.2.21 of this Addendum, the PFNW facility will use a grout form that is similar to cast stone. In this facility, the raw materials and liquid LAW will be mixed in an ICM. In this processing approach, the operator will move the mixing device vertically and laterally within the grout container to achieve a homogeneous mix. Although this approach is suitable for processing small containers at a relatively low throughput, the AoA team concluded that this processing approach is unsuitable for the OSGF.

The conceptual design for the SLWT project (including the Waste Solidification Unit [WSU]) is described in the SLWT Conceptual Design Report.[33]. Although the capacity of the OSGF would have to be approximately 10 times the capacity of the WSU, the AoA team considers the basic OSGF process operations and the equipment types and configuration to be easily scalable to achieve the required throughput for the OSGF. The WSU conceptual design is based on automated waste process lines that use larger grout containers. The WSU conceptual design was therefore chosen to provide the basis for the notional design for the OSGF as described below.

3.3.30.2 Process Functions and Equipment Configuration

The WSU conceptual design uses two process lines. Each process line performs the following functions:

- Storage of raw materials (e.g., Portland cement, blast furnace slag, and fly ash)
- Storage of concentrated (and pretreated) LAW
- Mixing liquid LAW batches
- Weighing and metering the raw materials
- Mixing raw materials and liquid LAW
- Filling grout container
- Conveying containers to/from filling, settling, and unloading stations along the process lines

After a container is filled, it will be removed from the conveyor by forklift and moved to a Solidified Waste Storage Building. The containers will remain in the building until the two-week cure time is complete. After curing, the filled containers will be loaded onto a truck or tractor transporter for transport to the IDF. A block flow diagram for the WSU is provided in SLWT Conceptual Design drawings[34].

The OSGF will require larger process equipment and more process lines than the WSU to achieve a tenfold increase in capacity. The appropriate number of process lines and the size of the process equipment and grout containers will be determined during design development. In addition to the increased capacity of the process lines and the need for a larger process building, the storage space in the Solidified Waste Storage Building would also need to increase.

A more complete description of the facility sizing and the equipment configuration for the OSGF is provided in Section 4.3.5 of this Addendum. This information was developed by the AoA team based on extrapolations from the WSU design as described in the SLWT Conceptual Design Report[33] and on the evaluation of the required facility treatment capacity provided in Section 4.3.5.2 of this Addendum.

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[33] Secondary Liquid Waste Treatment Project (T3W08) Conceptual Design Report, 2012, RPP-RPT-50967, Rev 0
[34] MGS Block Flow Diagram, drawing number H-2-839767, Sheet 1, Rev A

3.3.31 TRANSPORT GROUT CONTAINERS TO IDF

The transportation vehicle to be selected for transporting the grout containers to the IDF is dependent on the container size and weight and the proposed transportation route. As discussed in Section 3.3.30.2 of this Addendum, the size of the container will need to be determined during the OSGF design process.

3.3.32 DISPOSAL OF GROUT CONTAINERS AT IDF

The grout produced by the OSGF will be sent to the IDF for disposal. The grout containers will be off-loaded, emplaced, and backfilled in accordance with facility procedures (to be developed). Additional information on the IDF is provided in Section 4.1.6 of this Addendum and in Section 2.12 of Appendix A in the AoA Report.

As discussed in Section 4.1.6 of this Addendum, the space required for disposal of the grout produced by the OSGF exceeds the design capacity of the IDF. The AoA team did not evaluate the technical feasibility or cost impact for on-site or off-site disposal of the grout volume exceeding the IDF capacity.

4 Alternative 18 Facility Descriptions and Layouts

The tank farm, WTP (HLW Vitrification Facility, LAW Vitrification Facility, and WTP EMF), WRF, LERF/ETF, IHS, and IDF facilities are described in detail in the System Descriptions section of the System Plan[18] and are described at a summary level in Appendix B of the AoA Report. The new facilities that were required for other alternatives and needed for Alternative 18 (e.g., HFPEM Facility, WTV, LFE, and higher capacity ETF), are described at a preconceptual level in Appendix B of the AoA Report.

The design of the AP TSCR and the AP LILO Station were completed after the AoA Report was issued. The designs for these facilities are described at a summary level in the following subsections. References to the design basis documents for these facilities are provided where available.

The other new facilities needed for Alternative 18 (SY TSCR, SY LILO Station, and OSGF) are described at a preconceptual level in the subsections below. The off-site facilities required for Alternative 18 (PFNW and WCS) are also described at a summary level in the following subsections. In the case of existing facilities, the facility descriptions provided in the following subsections are focused on the differences in facility interfaces that are unique to Alternative 18.

Section 4 is organized by the Alternative 18 phases. To avoid duplication, each facility is only described once even though the same facility may be used in multiple phases. For example, the IDF is used in all phases but is only described in Section 4.1.6 of this Addendum.

4.1 Phase 1 Facilities

Phase 1 includes completion of construction and startup of the LAW Vitrification Facility. The only new capital investments required for starting LAW treatment in Phase 1 are for the AP TSCR and modifications to the ETF[35] to allow treatment of process condensate from the WTP facilities. The facilities needed for Phase 1B processing operations (beginning in 2025) will be completed during Phase 1 processing operations.

In Phase 1, the supernate currently stored in other DSTs (e.g., AP-105/107) in the SE Quadrant of the Tank Farm Complex and supernate that is retrieved from the SE Quadrant SSTs (A, AX, and C Tank Farms) will be sent to the AP TSCR for pretreatment.

New LAW and HLW processing facilities needed for Phase 1B operations that are constructed during Phase 1 include the SY TSCR and SY LILO Station in the West Area. The PFNW facility will also be modified during Phase 1 as required to

[35] Effluent Treatment Facility Assessment of Flowsheet Impacts from the Hanford Tank Waste Treatment and Immobilization Plant Effluent Management Facility Waste Profile, 2020, RPP-RPT-61923, Rev. 0

increase the treatment capacity before starting Phase 1B operations. These new and modified facilities are described in Section 4.2 of this Addendum.

4.1.1 SE QUADRANT SINGLE SHELL TANKS

There are 149 SSTs on the Hanford Site that were constructed between 1943 and 1964, with 66 SSTs located in the 200 East Area and 83 SSTs in the 200 West Area. A representative SST configuration is shown in Figure 4[36]. Of the 149 SSTs, 133 are 100-series tanks with an operating volume of 500 kilogallons (kgal) to 1.0 Mgal, while the remaining 16 tanks are 200-series tanks with an operating volume of 55 kgal. Nearly all the drainable interstitial liquids were removed from all SSTs to meet the criteria required by the SST interim stabilization program.

The SSTs in all the tank farms are not compliant with RCRA tank system requirements because they do not include secondary containment features. The SSTs in all the Hanford tank farms are described in more detail in Appendix B of the AoA Report and in the System Descriptions section of the System Plan.

The SE Quadrant SSTs are in the A, AX, and C Tank Farms. The SSTs in the C Tank Farm were previously retrieved, and no further waste removal is planned. The SST waste inventories in the A and AX Tank Farms consist primarily of sludges and crystallized salts, with only small amounts of free liquid. In total, these SSTs contain approximately 29 Mgal of waste.

The SST tank farms do not have the required infrastructure to transfer waste to the DST tank farms. The SE Quadrant SSTs in the A and AX Tank Farms are relatively close to the DST tank farms in the SE Quadrant. The bulk slurry that is retrieved from the SSTs can be transferred by HIHTLs to a DST in the SE Quadrant. Similarly, the SW Quadrant SSTs are located near the SY Tank Farm, and bulk slurry from retrieval of these tanks can be transferred by HIHTLs to a DST in the SY Tank Farm. In contrast, the SSTs in the B and T complexes are located too far from any DST tank farm. The bulk slurry from retrieval of these SSTs will be received in a tank/vessel in a WRF. The East Area WRF will provide pipe-in-pipe transfer lines to transfer the bulk slurry in the WRF tanks/vessels to a DST in the SE Quadrant. The West Area WRF will provide the pipe-in-pipe transfer lines to transfer the bulk slurry in the WRF tanks/vessels to the DSTs in the SY Tank Farm.

[36] Waste Tank Summary Report for Month Ending November 30, 2018, 2018, HNF-EP-0182, 2018, Rev. 371

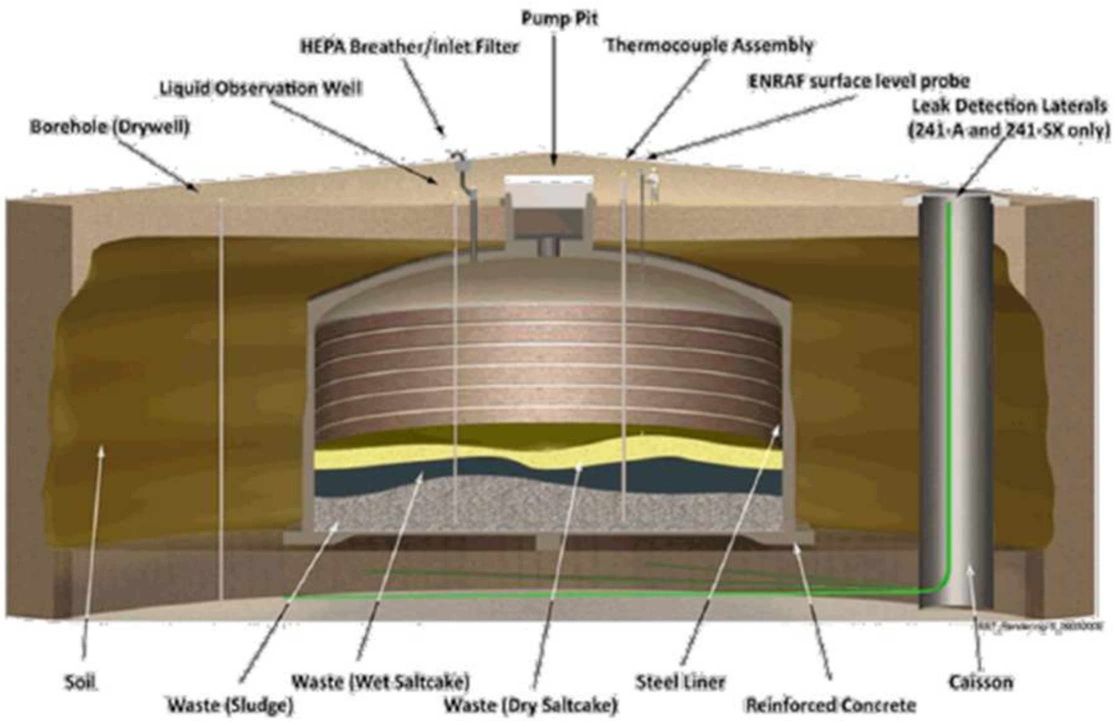

Figure 4: Representative SST Configuration

LAW supernate retrieved from SE Quadrant SSTs located in A and AX Tank Farms will be pretreated and treated starting in 2023 during Phase 1. The remaining HLW slurry will be pretreated and treated starting in 2033 during Phase 1B. Note that retrieval of the C Tank Farm SSTs was previously completed, and these tanks are in closure status.

The proximity of the SE Quadrant SSTs and DSTs and SW Quadrant SSTs and DSTs allows use of HIHTLs to accomplish SST to DST waste transfers in these respective quadrants. However, the NE and NW Quadrant SSTs are not proximate to their corresponding quadrant DSTs, which makes use of HIHTLs non-viable. The NE and NW Quadrant SST retrievals during Phase 2 will therefore rely on the WRF project to install new pipe-in-pipe transfer lines.

4.1.2 SE QUADRANT DOUBLE SHELL TANKS

The DSTs are grouped into six tank farms. There are five DST farms in the SE Quadrant (AN, AP, AW, AY, and AZ Farms) with a total of 25 DSTs. The DSTs will receive slurries and supernate from SST retrievals and store or pretreat the waste depending on the alternative selected. The DSTs differ from SSTs primarily by inclusion of a secondary containment liner. The DSTs contain liquids and settled solids, either salts or sludge. The DSTs functions will include storing waste, receiving SST retrievals, and sampling, characterizing, and staging LAW supernate and HLW slurry feed for delivery to the WTP[37]. The SE Quadrant DSTs will also receive secondary waste from both DFLAW and WTP process operations.

The DSTs in all the Hanford tank farms are described in more detail in Appendix B of the AoA Report and in the System Descriptions section of the System Plan[18]. Section 2.1 of Appendix B of the AoA Report also describes the DST modifications and upgrades to support the HLW and LAW treatment mission.

The SE Quadrant DSTs will be used for solids/liquid separation to segregate the waste into LAW supernate and HLW slurry. These operations will require mixing and settling the tank contents followed by decanting.

[37] In Phase 1B, HLW is pretreated in AP-101 if required. The pretreatment is limited to solids washing.

In Phases 1 and 1B, the supernate from the SE Quadrant DSTs will be transferred to AP-105 for mixing, sampling, and characterization. In Phase 2, additional DSTs in the SE Quadrant may have to be dedicated to LAW characterization and staging. The characterized LAW supernate will then be staged in AP-107 for delivery to the AP TSCR.

In Phases 1 and 1B, the remaining HLW sludge (slurry) from solid/liquid separation will be transferred to AP-101 to be sampled and characterized. The characterized HLW slurry will be transferred to AP-102 to be staged for delivery to the HLW Vitrification Facility. In Phase 2, additional DSTs will be designated for HLW slurry sampling and characterization. Also in Phase 2, the characterized HLW slurry that is staged in AP-102 will be sent to the HFPEM Facility to be pretreated before transfer to the HLW Vitrification Facility.

4.1.3 CROSS-SITE TRANSFER SYSTEM

Section 2.3 in Appendix B of the AoA Report describes the Cross-Site Transfer System. This system consists of separate supernatant and slurry transfer lines and waste transfer support systems that provide a RCRA-compliant transfer capability to transfer tank waste from the 200 West Area to the 200 East Area. The Cross-Site Transfer System was constructed in the 1990 timeframe but was never used. In 2012, a study was completed to determine the condition of the supernate and slurry lines and their support systems[38,39]. A project is planned to repair and upgrade the slurry line and associated systems. In Alternative 18, the slurry line is required for Phases 1B and 2 to transfer HLW slurry from SY 102/103 to a designated DST in the SE Quadrant.

4.1.4 AP FARM TSCR/TFPT

The AP TSCR and the TFPT facilities are described in Section 2.8 of Appendix A of the AoA Report. Additional design details for the AP TSCR are provided in Addendum C in DOE/ORP-2018-02, Rev. 2[17]. The AP TSCR is required to be in operation immediately after completing hot commissioning of the LAW Vitrification Facility on 12/31/2023 (date per ACD[13]). The AP TSCR has a limited pretreatment capacity (5 gpm) and design life (5 years). The current plan is to replace the AP TSCR with a higher capacity (10 gpm) pretreatment unit/facility (referred to as the TFPT) before the end of its design life (estimated 3/2028). The TFPT could use the same or similar filtration and IX technologies as the AP TSCR or could use different technologies that provide the same level of performance.

The TFPT will be installed in the 2028 timeframe and will operate until it is modified or replaced to further increase its capacity from 10 gpm to 20 gpm to meet the Phase 2 processing demand. Since the TFPT design is not yet developed, it is assumed the TFPT will use the same filtration and IX technology as the TSCR or another technology of similar state of technology readiness and design complexity.

In the TSCR design and the assumed TFPT design, AP-107 will provide a continuous feed supply to the TSCR via an HIHTL. The AP TSCR design includes filtration (using particulate filters) and cesium removal (using non-elutable resins in IXCs). The particulates removed by the filters will be sent to AP-108, and the filtered and cesium-depleted output from the IXCs will be collected in AP-106 where it will be staged for delivery to the LAW Vitrification Facility (Phases 1 and 1B) or to the LFE (Phase 2).

In the TSCR, “dead-end” filters will protect the IX media by removing particulates. The filters will be periodically back-pulsed with process air to remove the collected particulates. The IXCs will be configured in a lead, lag, and polishing arrangement. The lead and lag IXCs will remove cesium by absorption onto the IX media. When the IX media becomes saturated, the lead and lag columns will be replaced, and the polishing column will become the lead column.

After exiting the lag and polishing IXCs, the pretreated LAW will be routed to a Delay Tank. The Delay Tank will include an internal baffling arrangement that allows enough retention time for the decay of the metastable Barium-137. Gamma monitoring will be performed before routing the pretreated LAW to AP-106.

In the TSCR design, the filters, IXCs, Delay Tank, and the ventilation exhaust system will be located in a TSCR Process Enclosure. The Process Enclosure will be surrounded by a shield wall that abuts the east side of the AP Tank Farm fence.

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[38] Reactivation of the Replacement Cross-Site Transfer System – Supernatant Line SNL 3150, 2018, RPP-RPT-60825, Rev. 0
[39] Cross-Site Slurry Line Evaluation Report, 2011, RPP-RPT-47572, Rev. 0

An Ancillary Enclosure will provide storage for sodium hydroxide and will house the process water and service air systems. A Control Enclosure will house the monitoring and controls systems for the TSCR. The Ancillary and Control Enclosures will be located adjacent to the south side of the shield wall. The IXC Storage Pad will be located inside a vehicle barrier and security fence northeast of the TSCR Process Enclosure.

4.1.5 LAW VITRIFICATION FACILITY

The LAW Vitrification Facility includes two melter systems operated in parallel. Each melter system has a dedicated MFP vessel that receives feed from AP-106 (Phases 1 and 1B) or the LFE (Phase 2) and a Melter Feed Vessel (MFV) that stages feed for delivery to the melter. Each melter system includes a joule-heated ceramic-lined melter, and an off-gas treatment system. The facility also has a secondary off-gas system shared by the two melter systems. Figure 5 provides an aerial view of the LAW Vitrification Facility. Additional design details are provided in the Design Descriptions section of the System Plan[18].

Figure 5: WTP LAW Vitrification Facility

Each LAW melter is designed to operate at a design capacity of 15 metric tons of glass (MTG)/day. An airlift system pours the glass from the melter into stainless steel containers. After being filled, each ILAW container cools for several days, then a lid is sealed to the top of the container, and external contamination is removed. Each ILAW container will hold 5.51 MTG on average and is staged in a temporary staging area in the LAW Vitrification Facility. The ILAW containers are subsequently transported to the IDF for disposal. Section 2.9 of Appendix A of the AoA Report and the System Descriptions section of the System Plan[18] provide a more detailed description of the LAW Vitrification Facility.

4.1.6 INTEGRATED DISPOSAL FACILITY

The IDF is a landfill in the 200 East Area of the Hanford Site that is permitted to receive solid low level waste (LLW) and MLLW. The IDF includes two existing cells that were completed in 2006, which are approximately 13 meters deep. The IDF is designed to be expanded to a total capacity of six cells as additional disposal space is needed. An aerial view of the IDF is provided in Figure 6. Additional details on the IDF are provided in the System Descriptions section of the System Plan[18] and in the IDF Performance Assessment[29].

The IDF is permitted to receive and dispose of the following waste streams:

- ILAW containers
- Spent or failed LAW melters (including overpack)
- ETF solid secondary waste (i.e., solidified brine from the Secondary Treatment Train evaporator)
- Miscellaneous solid waste

Figure 6: Integrated Disposal Facility

Table 4-9 of the IDF Performance Assessment[29] provides the estimating assumptions for the waste and backfill volumes required for each of these waste streams. For all alternatives including Alternative 18, the LAW treatment rate that is needed to keep pace with HLW treatment exceeds the capacity of the LAW Vitrification Facility. For Alternative 18, this LAW stream (referred to as LAWST in the AoA Report) will be grouted in the OSGF. The grout containers will then be disposed of at the IDF. It is assumed that a new IDF Performance Assessment based on grouting of the LAWST in the OSGF will be able to demonstrate that the LDR requirements can be met.

The IDF capacity as specified in the Performance Assessment[29] is approximately 900,000 cubic meters (m^3). For Alternative 18, the waste streams that will need to be accommodated by the IDF include ILAW containers from the LAW Vitrification Facility, spent or failed LAW melters (with overpack), ETF generated solid waste, other miscellaneous secondary solid wastes from the Hanford Site, and grout containers from the OSGF. Excluding the OSGF grout container volume, the total volumes of the as-disposed waste volumes plus backfill for the solid waste streams to be disposed of at the IDF are, respectively, 162,000 m^3, 37,000 m^3, 48,000 m^3, and 30,000 m^3 for a subtotal of 277,000 m^3.

WRPS modeling data showed the OSGF produced a grout volume in Phase 2 of 393,000 cubic yards (yd^3) or 300,000 m^3, assuming all the West Area LAW is treated and disposed off site[40]. The AoA team assumed that the OSGF would be designed to have the capacity to allow grouting of all the LAW produced during Phase 2, including the LAW from the West Area tanks. The additional grout volume from treating the West Area LAW in the OSGF during Phase 2 is 252,000 yd^3 or 193,000 m^3. This yields a total Phase 2 OSGF grout volume of 493,000 m^3.

Assuming the same ratio for the volume of "waste and backfill" to the "as-disposed waste volume" for the ETF grout (evaporator brine), the volume of space taken up in the IDF for disposal of the OSGF grout is approximately 493,000 m^3 x 2.54 = 1,252,000 m^3. This value significantly exceeds the IDF capacity of 900,000 m^3. If the "as-disposed of waste" plus "backfill" volumes for the other waste streams are added (i.e., 277,000 m^3), the total required IDF capacity needed for Alternative 18 is 1,529,000 m^3.

[40] The WRPS process model assumed that the LAW feed to be grouted in the PFNW facility was unconcentrated (approximately 10 wt.%). Since the OSGF receives concentrated feed from the LFE (approximately 15 wt.%), the volume of grout that is produced is somewhat less than that predicted by the WRPS process model.

Table 6 summarizes the volumes of LAW feed and immobilized waste product for each of the LAW treatment facilities used in each phase of Alternative 18.

Table 6: LAW Treatment Facility Feed and Immobilized Waste Volumes

LAW Treatment Facility	Phase(s)	LAW Feed Volume (Mgal)	Immobilized Waste Volume (m^3)
LAW Vitrification Facility	1, 1B, and 2	47	162,000
PFNW Facility	1B	37	193,000[41]
OSGF	2	84	300,000

4.1.7 WTF EMF

The WTP EMF design is summarized in the System Descriptions section of the System Plan[18]. A more detailed description of the design is provided in the EMF System Design Description[42]. The WTP EMF consists of a main building with a Process Area, Concentrate Tank Area, Drain Tank Area, Condensate Tank Area, Utility Building, Electrical Building, Stack, and a Truck Bay. The Process Area contains two sections, one for the Evaporator and Reboiler and one for the Condenser and process ventilation. An 'Evaporator Area' and a 'Process Area' are shown in the WTP EMF drawings. Each of these areas include space for pumps. The total Evaporator Area plus the Process Area is approximately 10,400 square feet (ft^2).

The WTP EMF receives the liquid effluents from the LAW Vitrification Facility and evaporates the water and other volatile compounds contained in the feed stream. The evaporator concentrate is recycled to the LAW Vitrification Facility, and the evaporator condensate is pumped to the LERF/ETF for treatment.

4.1.8 LERF/ETF

The LERF consists of three basins (covered double-lined surface impoundments) each having a capacity of 6.76 Mgal. A fourth basin was partially constructed and abandoned. Construction on this basin is planned to resume in 2022[43]. The basins are used to stage ETF feed (e.g., 242-A evaporator process condensate). Section 11 of Appendix B of the AoA Report describes the LERF and ETF in more detail.

The ETF can treat low-activity radioactive water containing small amounts of ammonia, inorganics, organics, and particulates. The ETF includes a process building (Building 2025E) that contains a control room that provides the capability of monitoring and controlling the treatment process and the treatment systems; a chemical makeup and storage area; secondary waste treatment and storage systems, and off-gas and ventilation systems along with various support systems including fire protection, communications, sanitary and raw water, and electrical systems. A Load-In Station (Building 2025ED) provides tanker truck offload capabilities, while external tank storage is provided for liquid waste awaiting treatment, process chemicals, and treated effluent awaiting analysis and/or verification.

Section 3.1.9 of this Addendum also provides an evaluation of the treatment capacity of the existing ETF. This evaluation concluded that the existing ETF, once modified as described in the ETF Flowsheet Assessment[20], will have adequate capacity to treat the process condensate generated in Phase 1 (and Phase 1B).

The ETF Flowsheet Assessment Report concluded that the existing ETF would need to be modified to provide more robust treatment capabilities. Additionally, the flowsheet assessment determined that a grout or other waste stabilization process would be required to treat the brine from the ETF evaporator. The facility modifications necessary to implement the recommendations in the ETF Flowsheet Assessment are currently in progress. These modifications include:

- Installation of redundant filtration capability

[41] The grout produced by the PFNW facility in Phase 1B will be disposed of in the WCS facility in TX (see section 4.2.7 of this Addendum).
[42] Effluent Management Facility Design Description and System Design Descriptions (ACV, C1V, DEP, DVP), 2015, 24590-BOF-3ZD-25-00001, Rev. 2
[43] ETF/TEDF/LERF Life Cycle Study, 2019, RPP-RPT-61547, Rev. 0

- Installation of a carbon dioxide membrane
- Installation of steam stripping system
- Installation of lag storage tanks for ETF brine
- Installation of a modular grout system for immobilization of brine

4.2 Phase 1B Facilities

The Phase 1B processing operations rely in part on the same processing facilities that were used in Phase 1, which continue to operate during Phase 1B. The LAW characterization, staging, pretreatment, vitrification, and effluent management process functions and facilities in the East Area for Phase 1B are the same as Phase 1. Phase 1B adds new pretreatment, off-site grouting, and off-site disposal functions and facilities to process the LAW in the West Area. HLW pretreatment and vitrification will begin later in Phase 1B when the HLW Vitrification Facility starts up in 2033.

Except for the modifications to the SE Quadrant DSTs needed for HLW pretreatment, all the other facilities in the East Area do not require any modifications and will continue to operate in the same manner as during Phase 1. The following sections describe the additional facilities that that are needed for Phase 1B.

4.2.1 SE QUADRANT DOUBLE SHELL TANKS

The SE Quadrant DSTs will be used to segregate the waste into LAW supernate and HLW slurry by mixing, settling, and decanting. During Phase 1B, the supernate will be transferred to AP-105 (or other designated DST) for mixing, sampling, and characterization. The characterized LAW supernate is transferred to AP-107 to be staged for delivery to the AP TSCR/TFPT as discussed in Section 4.1.5 of this Addendum.

The HLW slurry in the SE Quadrant DSTs will be transferred to AP-101 for sampling, characterization, and pretreatment (solids washing). The washed HLW slurry will be transferred to the DFHLW feed tank AP-102 where it will be staged for delivery to the HLW Vitrification Facility via the WTV as discussed in Section 4.2.8 of this Addendum.

The mixing, pretreatment, and slurry transfer operations in AP-101 and AP-102, as well as any other SE Quadrant DSTs that are designated to perform these operations, will require the installation of mixer pumps, slurry transfer pumps, and other process support equipment. These modifications are described in detail in section 2.1 of Appendix B of the AoA Report.

4.2.2 SW QUADRANT SINGLE SHELL TANKS

The SW Quadrant SSTs (S, SX, and U Tank Farms) will be retrieved beginning in Phase 1B. These retrievals will be complete early in Phase 2 (2055). The retrieved bulk slurry from the SW Quadrant SSTs will be collected in SY-102/103. Since the S, SX, and U Tank Farms are located near the SY Tank Farm, HIHTLs are planned to be used to transfer the retrieved waste to a receiving DST (SY-102 or SY-103).

4.2.3 SW QUADRANT DOUBLE SHELL TANKS

The DSTs in all the Hanford tank farms are described in more detail in Appendix B of the AoA Report and in the System Descriptions section of the System Plan[18]. Section 2.1 of Appendix B in the AoA Report also describes the DST modifications and upgrades to support the HLW and LAW treatment mission.

The SY Tank Farm is the only DST tank farm in the SW Quadrant, and it includes three DSTs: SY-101, SY-102, and SY-103. Section 4.1.2 of this Addendum provides a general description of the DSTs. Although the SW Quadrant DSTs are not used during Phase 1, they will be modified during Phase 1 in preparation for use at the start of Phase 1B.

The retrieved waste from the SW Quadrant SSTs will be collected in either SY-102 or SY-103. Settling and decanting will be performed in the receiving DST to separate the solids and liquids. The LAW supernate will be decanted to the other ‘non-receiving’ DST (SY-103 or SY-102) and sampled and characterized.

The characterized LAW supernate will be transferred to SY-101 where it will be staged for delivery to the SY TSCR. When the combined settled solids level of SY-102 and SY-103 reaches 400 inches, the HLW slurry will be transferred to a designated DST in the SE Quadrant via the Cross-Site Transfer System slurry line.

4.2.4 SY FARM TSCR

The SY TSCR is required to be in operation by 1/2026 which is coincident with the start of Phase 1B operations. As discussed in Section 4.1.4 of this Addendum, the AP TSCR is required to be in operation immediately after completing hot commissioning of the LAW Vitrification Facility on 12/31/2023[13]. For purposes of the AoA, the SY TSCR is assumed to be of similar design and configuration as the AP TSCR (TSCR Demonstration Facility). The design details for the AP TSCR as described in Addendum C in DOE/ORP-2018-02, Rev 2[17], are therefore assumed to be applicable to the SY TSCR.

The SY TSCR treatment capacity of 5 gpm is adequate for all phases of Alternative 18. Since there is no need to develop a new design for a higher capacity TSCR, it is assumed that the same system will remain in service, with periodic component replacement as required, for the duration of the tank waste treatment mission.

The AP TSCR design includes the necessary modifications to the AP Tank Farm waste transfer pumps, pump pits, jumpers, valve manifolds, and leak detection that will connect the AP TSCR to AP-107, AP-106, and AP-108. The SY TSCR project will need to include similar infrastructure modifications to route supernate feed to the SY TSCR.

4.2.5 SY LILO STATION

The SY LILO Station function and design features differ from those for the AP LILO Station (described in Section 4.3.9 of this Addendum) in several significant ways. These differences include transferring waste to, rather than from, a tanker car; lack of an available DST to stage pretreated LAW; and the differences in the SY and AP Tank Farm DSTs, waste transfer systems, and process and utility support systems. Because of these differences, a separate preconceptual level design basis was developed for the SY LILO Station.

4.2.5.1 SY LILO Station Interfaces

The SY LILO Station will provide the capability to transfer pretreated LAW from the SY TSCR to a tanker truck. It is assumed that the SY TSCR and LILO Station will be in an area adjacent to the SY Tank Farm. It is also assumed that the scope of a capital project to design, construct, and commission the SY TSCR and the West IXC Storage Pad will also include the SY LILO Facility. This group of facilities or subprojects is referred to herein as the SY TSCR complex.

The SY LILO Station design is expected to be similar to the design developed for the AP LILO Station. The basis facility architecture includes HIHTLs, waste transfer pumps, pump pits, jumpers, and valves to route pretreated LAW from the SY TSCR to a tanker truck located on a pad inside of a weather enclosure. A Control Enclosure is also provided to monitor the waste transfer and tanker truck filling operations.

4.2.5.2 SY LILO Station Design

In Alternative 18, LAW supernate from the West Area tanks will be staged in SY-101 and pretreated in the SY TSCR. In Phase 1B, the pretreated LAW will be transferred to a tanker truck in the SY LILO Station and then transported off site for treatment. In Phase 2, the pretreated LAW from the SY TSCR will be transferred to the SY LILO Station, and the tanker truck will transport it to the AP LILO Station. Using this approach, the supernate line within the Cross-Site Transfer System will not be required to transfer supernate from the SY Tank Farm to the SE Quadrant DSTs.

Since the SY LILO Station will be required to perform similar functions as the AP LILO Station, the AoA team assumed the SY LILO Station will be similar to the AP LILO Station described in Section 4.3.9 of this Addendum. The AoA team also assumed that the SY TSCR and SY LILO Station will be constructed as part of a single project, and both facilities will be in an area adjacent to the SY Tank Farm. The primary difference between the AP and SY LILO Stations is that the SY LILO Station will connect directly to the downstream side of the SY TSCR facility rather than to another DST in SY Tank Farm.

The SY LILO Station has not been designed, and it is not clear what piping, pump/valve pits, HIHTL, and other infrastructure modifications would be required to connect the SY TSCR to the SY LILO Station. The AoA team therefore assumed that the scope of work involved in connecting the SY TSCR to the SY LILO Station is similar to the scope of work required to connect the AP LILO Station to AP-106, AP-107, and AP-108. Based on this assumption, the AP LILO Station Functional Requirements Specification[24] is assumed to be generally applicable to the SY LILO Station.

4.2.5.3 Tanker and Surge / Staging Vessel Capacities

The SY LILO Station and the site infrastructure for transporting the tanker truck(s) to the AP Farm LILO Station and off-loading a tanker truck(s) at the AP LILO Station must be capable of keeping pace with the rate at which pretreated LAW is generated by the SY TSCR. The WRPS process modeling results show that the rate at which LAW will have to be pretreated in West Area is approximately 2.2 Mgal/year which equates to a processing rate of 4.2 gpm.

The SY TSCR would need to sustain a pretreatment rate of 4.2 gpm for a year or longer for the LAW processing rate to keep pace with HLW processing. As discussed in Section 3.2.17 of this Addendum, the SY TSCR will have a minimum design capacity of 5 gpm to sustain and average processing rate of 4.2 gpm. The LILO system including the SY and AP LILO Stations and the tanker trucks must therefore be able to sustain a minimum transfer rate of 5 gpm. The tanker trucks are planned to be vendor designed and fabricated. The Functional Requirements Specification for the AP LILO Station[24] requires each tanker truck to have a minimum capacity of 5,040 gallons.

The SY Tank Farm DSTs do not have adequate capacity and redundancy to be able to stage pretreated LAW from the SY TSCR[44]. Two new staging vessels will therefore be required to allow the SY TSCR to continue to operate while pretreated LAW is being transferred to a tanker truck in the SY LILO Station. These vessels could be above grade since the TSCR facility will have removed all the cesium.

The staging vessels would need to have adequate capacity to hold the volume of pretreated LAW generated by the SY TSCR for the time that it takes to fill the tanker, move the loaded tanker out of the concrete pad/enclosure, bring in an empty tanker, and connect it to the SY TSCR. Assuming that the time required to complete these operations is 12 hours, and the SY TSCR throughput is 5 gpm, each of the two staging vessels would be required to have a fill capacity of 3,600 gallons. A time/motion study would be required to finalize the capacities of the tanker and the staging vessel for the SY LILO Station.

4.2.5.4 SY LILO Station Safety Functions and Engineered Controls

Section 4.3.9.2 of this Addendum describes the safety functions and engineered controls for the AP LILO Station based on a preliminary hazards analysis (PHA)[45]. The largest contributor to the source term for radioactive releases from untreated LAW is cesium-137. Because the TSCR process removes the cesium from the LAW feed, the source term for radioactive releases from accidents in the AP or SY LILO Stations is relatively low.

The AP LILO Station PHA does not identify the need for engineered controls to protect workers or the general public from radioactive releases due to accidents in the LILO pad and weather enclosure. However, jet spray events do pose chemical burn hazards for the facility worker. The PHA concluded that the LILO Station pad and weather enclosure will provide a defense in depth function to protect the facility from jet spray events due to a seismic event. The pad and weather enclosure for the AP LILO Station are therefore designed to Seismic Design Category (SDC) 2 requirements.

Although a PHA has not been performed for the SY LILO Station, it is reasonable to assume the jet spray events inside the weather enclosure would have the same consequences and would require the same engineered controls as the AP LILO Station. It is therefore assumed that the LILO pad and weather enclosure for the SY LILO Station would also be designed to SDC-2 requirements.

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[44] SY-102/103 are used to receive the bulk slurry from SST retrievals in the West Area, separate liquids and solids, and hold decanted supernate while it is sampled and characterized (see Sections 3.2.15/16 of this Addendum). SY-101 is used as a staging tank for transferring characterized supernate to the SY TSCR in a continuous flow mode. Since all the DSTs in the SY Tank Farm are dedicated to other functions, it is not possible to designate a DST to receive pretreated LAW from the SY TSCR.
[45] Process Hazard Analysis for the 241-AP Farm Truck Load-In/Load-Out Station Project (T5L02), 2020, RPP-RPT-62195, Rev. 0

The PHA for the AP LILO Station credits the underground pumps, piping, jumpers, pump pits, and nozzles, and the associated leak detection systems and components for waste confinement purposes. To prevent seismic induced leaks, these SSCs are classified as Safety Significant (SS) and have been designed to meet SDC-2 requirements.

Although the design for the SY LILO Station has not started, it is assumed that the only waste transfer systems and components that will be required include staging vessels, waste transfer pumps, valves, and HIHTLs. These systems and components are assumed to be located above grade. Although the AP LILO Station does not have staging vessels, the other above-grade components should be similar for the SY LILO Station. Since the SY LILO Station will connect to the TSCR instead of a DST, the location of these components and the routing of the HIHTLs will be different.

The AP LILO Station PHA concluded that Safety Administrative Controls provide adequate protection from jet spray events from above-grade SSCs located within the AP Tank Farm or within the fenced boundaries of the AP LILO Station. Since the component locations and the need for Operators to be present in these areas could be different for the SY LILO Station, it is possible that the engineered control sets may be different. As a conservative measure, the AoA team assumed that all the SSCs used for waste transfers to the SY LILO Station would be classified as SS and SDC-2.

4.2.6 PFNW FACILITY

PFNW operates a MWF on a 35-acre site in the city of Richland, Washington, as shown in Figure 7. The MWF includes the STB that is equipped with systems to treat and stabilize a wide variety of MLLW[46]. Materials treated may contain both organic and inorganic matter. The PFNW Facility will receive pretreated LAW liquid via tanker trucks loaded at the SY LILO Station and transported over the Hanford site and city roadways. The LAW liquid is treated (grouted) at the PFNW Facility using the ICM process included in the STB.

The following sections describe the PFNW Facility permits and license, the STB, and the ICM system and process capacity.

Figure 7: PFNW Site (Google Earth Image)

4.2.6.1 Facility Permits and License

A Dangerous Waste Permit (DWP) and TSCA (Toxic Substances Control Act) approval were issued to PFNW by the Washington State Department of Ecology (Ecology) on July 7, 1999. The DWP allowed PFNW to treat and store LLW and MLLW. A Class 2 Permit Modification for an ICM was approved by Ecology on April 24, 2020. Ecology also made an

[46] Letter 2020-LTR-1002, dated January 17, 2020, PMR-202 In-Container Mixer Class 2 Permit Modification, Perma-Fix Northwest Richland, Inc., Attachment PP - Process Engineering Description for Stabilization Building Mixed Waste Facility RCRA/TSCA Permit, Perma-Fix NW, Inc., Richland Washington

environmental impact determination of “non-significance” under the State Environmental Policy Act (SEPA) in conjunction with the DWP modification.

PFNW is currently seeking renewal of its DWP. Ecology is in the process of preparing a Supplemental Environmental Impact Statement (SEIS) in support of the renewal of the DWP.

The PFNW facility also has an Air Operating Permit (AOP) for radioactive emissions. The AOP was issued by the Washington Department of Health (WDOH).

WDOH also administers the PFNW radioactive material license. WDOH issues an Environmental Report each year to provide an annual assessment of compliance with the terms of the AOP and the Nuclear Regulatory Commission (NRC) license.

4.2.6.2 Stabilization Building Description

The STB will house four of the five treatment lines included in the MWF[46]. These treatment lines include primarily non-thermal operations and the processing of dangerous wastes. The STB will include an existing building (Building 13 [Bldg13]) and a new annex. The existing Bldg13 has a floor area of 15,000 SQF divided into three 5,000 SF rooms. Each room is separated from the other by a fire wall. The new annex building will have 6,820 SF. The configuration of the fire walls in Bldg13 will be kept intact, but additional partitions and access doors will be added inside one of the three rooms as needed to support the new functions. The existing Bldg13 slab will be modified to provide equipment foundation support and secondary containment features.

The STB houses four treatment lines (100, 200, 300, and 400) each designed for treating a given waste stream. Line 100 treats soils and inorganic debris; line 200, liquids and slurries; line 300, bulk lead and metals; and line 400, heterogeneous solids and debris. Each treatment line is designed to pre-treat and treat the waste to meet RCRA LDR requirements. The overall STB process functions include:

- Initial staging and inspection of the incoming waste
- Pretreatment of the waste, including sorting, size reduction, drying, and chemical adjustment
- Treatment of the waste, according to the RCRA LDR regulations, encompassing (a) stabilization by mixing/chemical reactions with either cement or polymer-based reagents; (b) immobilization by macro- encapsulation; (c) physical extraction by abrasive blasting; or (d) washing, rinsing, and grouting of wastes (e.g., metal turnings)
- Handling, treatment, and disposal of secondary waste
- Final packaging and certification of the treated waste according to LDR regulations

4.2.6.3 ICM System Description

Table 7 provides system description information for the ICM System (TT-03) that is part of the STB 200 treatment line and relevant to grouting LLW and MLLW. The ICM process line is described in more detail in Attachment PP to the DWP[47]. The ICM System will be used to provide stabilization processes (per dangerous waste treatment standard) by mixing liquid, slurry, and solid wastes in a container that serves both as the mixing vessel and, as necessary, the final disposal container. ICM System-specific functions include:

- Receiving containerized waste
- Receiving stabilization reagents
- Mixing waste with reagents
- Sampling stabilized waste product and verifying compliance with LDR requirements
- Capping stabilized waste containers
- Inspecting for container external contamination and decontaminating as needed
- Transporting filled containers to the containerized waste staging area (permitted storage area) for certification and shipping

[47] Attachment PP (Process Engineering Description for Stabilization Building) to PMR-202 In-Container Mixer Class 2 Permit Modification

The ICM System will use a mixer blade mounted on a vertical shaft. A drum ventilation lid will be provided to cover the container during stabilization and mixing operations. A vent from the container will be connected to the STB process vent system. Mixing will be accomplished underneath the mixer mounted to a steel frame. Several generic blends of cement-based reagents are described that are similar to the cast stone grout formulation (see Section 3.3.30 of this Addendum).

Section 4.2.6.4 of this Addendum compares the ICM System capacity to the SY TSCR capacity.

Table 7: STB ICM System and Supporting System Descriptions[46]

System	Unit ID	Treatment Line #	Throughput	Location	System Description
ICM System	TT-03	200	75 gallons liquid waste/hour (or 1.25 gpm) @ 600 gal/8-hour shift 1,071 pounds of solid waste/hour[48]	Bldg13	The system will be designed to mix waste with reagents in 55-gallon drums. Batches of incoming solid, slurry or liquid waste will be pre-treated in the container in accordance with requirements established by the treatability tests. The mixing will be accomplished by placing the waste container under the mixing station, clamping it down, lowering the mixing blade and drum ventilation lid to cover the top of the container, feeding the desired reagent mixture to the container while the mixer is turned on, and allowing the mixing to continue until the desired cycle mixing is complete. The operator will visually verify that the material is homogenous. Signs of streaks, clumps, free liquids, or color variations will be used to determine completion of mixing. The mixer will then be stopped and raised out of the container, and the container will be capped and set aside for curing (if necessary). Since an in-container concept is used, only the mixer blade will require rinsing. The drum containing rinseate will be filled with waste and stabilized in the next waste stabilization campaign. Stabilization reagents will be pre-proportioned in a bulk bag in accordance with the reagent formulation specified for a given batch of waste. The bulk bags of mixed reagents will be transferred to system TT-03 using a fork lift or pallet jack. The bulk bag will be attached to the bulk bag unloading system which will elevate and position the bulk bag directly above the reagent feeder.
STB Building and Structures System	SB-07	N/A	N/A	Bldg13	STB equipment will be housed inside existing Bldg13. The building slab will be modified to include equipment support pads and secondary containment and be sealed with a protective coating. An annex adjoining Bldg13 will be built to house the size reduction/screening system, the confinement system, and the bulk reagent storage system.
STB Containment System	SB-06	N/A	N/A	Bldg13	Secondary containment will be included in the STB to collect any potential liquids spilled during the handling and processing of material in the STB. The secondary containment will include a concrete curb constructed around the building perimeter and additional containment pans under the tanks and the individual systems as necessary. Secondary containment for TT-03 will be provided by a metal pan which will be an integral part of the floor that supports the mixing system. The pan will cover the entire mixing station enclosure floor and will be designed to have a free volume to contain the spillage from the entire volume of the largest container that is processed in the mixing station (i.e., a 55-gallon drum).

[48] The ICM throughput is limited by the DWP. Section 4.2.6.4 of this Addendum compares the ICM System capacity to the capacity/throughput requirements for the LAW to be grouted by the PFNW Facility in Phase 1B.

System	Unit ID	Treatment Line #	Throughput	Location	System Description
STB Process Vent System	SB-09	400	N/A	Bldg13	Routine and normal fugitive emissions, fumes, particulates, and process vents in the STB will be controlled by the STB process vent system. The system will collect gases from the pretreatment and treatment system vent lines, process hoods, and enclosures where there is a potential for generating fugitive emissions. Vent gases will be filtered, if necessary, to remove dust and particulates, and will then be sent to two carbon filter banks, installed in series, to remove any organic vapor constituents in the gas. Emissions from the TT-03 system will be minimized by the process ventilation system (SB-09) providing airspace confinement of waste-bearing equipment. The control of fugitive emissions will be provided by a process ventilation port connected to the drum ventilation lid and another over the TIC. This process vent system uses a cyclone dust separator and carbon filtration to treat any particulate and organic vapors that may be generated during the stabilization operation. The vent from the stabilization process is treated for a second time by discharging the STB process vent system exhaust to the STB confinement system which has HEPA and carbon filters.
STB Confinement System	SB-02	400	N/A	Annex	The STB ventilation system, referred to as the “STB Confinement System,” has a pre-filter bank, a HEPA filter bank, and a carbon filter bank. Redundant fans provide the suction needed to pull exhaust air from the process areas through the pre-filter/HEPA/carbon filters and the facility discharge stack. The fans will also be able to maintain a negative pressure inside the STB while providing a minimum of seven air changes per hour.

4.2.6.4 ICM System Process Capacity

The WRPS process model predicts that the annual volume of pretreated LAW produced by the SY TSCR will be approximately 2 Mgal/year from the beginning of Phase 1B (2025) through 2050. The highest volume generated in any year within this period is 2.2 Mgal in 2035. To keep pace with the rate at which pretreated LAW is produced by the SY Farm TSCR, the PFNW Facility must be able to sustain a processing rate of 4.2 gpm for at least one year.

The DWP limits the capacity (throughput) of liquid LAW and MLLW processing within the ICM system to 75 gallons/hour (1,800 gallons/day) or 7.52 tons/day. This is equivalent to a treatment rate of 1.25 gpm. To sustain a treatment rate of 6 gpm, at least five ICM process lines would need to operate continuously (24/7) to process the LAW that is produced by the SY TSCR in Phase 1B. PFNW would need to perform an engineering study to determine what modifications would be required to the STB and supporting infrastructure to support five ICM process lines. PFNW would then need to seek approval of another DWP modification to allow operation at this higher treatment rate.

The STB may not have enough unallocated space to accommodate four additional ICM process lines. The facility infrastructure would have to be evaluated to determine what modifications would be required to the process support and utility systems to serve five ICM process lines. It is assumed that the basic facility infrastructure is adequate to support tanker truck off-loading and raw material deliveries at the rates expected.

4.2.7 WCS FACILITY

The WCS Facility is an NRC licensed LLW and MLLW treatment, storage, and disposal facility located in Andrews County, Texas. The facility licensee is Waste Control Specialists, LLC, and the WCS Facility provides radioactive waste management services including treatment, storage and disposal of Class A, B and C low-level radioactive wastes, as well as LAW, hazardous waste, and byproduct materials. WCS has co-located treatment, storage, and disposal facilities that are coupled with Type A and B cask and transportation services and rail-served site. The WCS Facility is located on a 14,000-acre site. The site is situated above a natural barrier of a 600-foot-thick, nearly impermeable red-bed clay formation. Figure 8[49] provides an aerial map of the WCS Facility.

[49] wcstexas.com/about/our-facilities/facility-site-map/

Figure 8: WCS Facility Site Map

The DOE has a fixed unit rate contract with Waste Control Specialists, LLC for disposal of all classes of LLW and MLLW[50].

4.2.8 WTV

The WTV will act as an intermediary transfer point between the AP Tank Farm and the HLW Vitrification Facility (Phase 1B) or between the HFPEM Facility and the HLW Vitrification Facility (Phase 2). The WTV is assumed to be located near the HLW Vitrification Facility to facilitate waste transfers and line draining and flushing operations.

In Phase 1B, pretreated HLW slurry from AP-102 will be transferred to an HFV in the WTV. The pretreated HLW slurry in the HFV will be recirculated through a 3-way valve in the HLW Vitrification Facility. The 3-way valve will divert HLW slurry to one of the MFP vessels on an as-needed basis. In Phase 2, the WTV will receive pretreated HLW slurry from the HFPEM Facility. The recirculation loop between the HFV and the HLW Vitrification Facility will operate in the same way as for Phase 1B.

The secondary function of the WTV will be to receive and transfer liquid effluents from the HLW Vitrification Facility. Liquid effluents will be collected in RLD-VSL-00007 within the HLW Vitrification Facility. After chemical adjustment, the effluents will be transferred to RLD-VSL-00008, also within the HLW Vitrification Facility. These effluents will either be pumped or gravity drained to the HLW Effluent Collection Vessel within the WTV. The Effluent Collection Vessel contents will then be transferred to a designated DST in the SE Quadrant (Phase 1B) or to one of the evaporator feed vessels within the HFPEM Facility (Phase 2).

[50] DOE Contract Number 89303318DEM000004 issued 8/23/2017

As described in Section 8.2 of Appendix A and Section 9 of Appendix B of the AoA Report, the pre-conceptual design features for the WTV Facility include:

- HLW Effluent Collection Vessel and HFV (24 kgal each) located in a below-grade concrete pit (vault) with a stainless-steel liner that provides a secondary containment
- Safety class (SC) vessel ventilation and active confinement ventilation systems located in a safety systems building
- SC compressed air system for post-design basis event air sparging of vessels also located in safety systems building
- SC emergency electrical power and essential monitoring and control systems also located in safety systems building
- Sodium hydroxide and sodium nitrite tanks for chemical adjustment of effluents located on a cold chemical pad
- Normal utility supply systems located in a utility supply building

It is assumed that given the material at risk (MAR) in the HFV within the WTV, the WTV Facility will require classification as a Hazard Category 2 facility.

4.2.9 HLW VITRIFICATION FACILITY

The pretreated HLW slurry from AP-102 will be transferred to the HFV in the WTV. The HLW slurry from the HFV will then be transferred into one of the MFP Vessels (HFP-VSL-00001/5).

The HLW slurry will be blended with glass forming materials in the HLW MFP vessels, and the mixture will be sent to one of the MFVs (HFP-VSL-00002/6). The MFVs will supply feed to one of the two dedicated HLW melters. The feed slurry will be introduced into the top of the melter and will form a cold cap on top of the melter pool. Water and volatile gases will be drawn out of the melter by the melter off-gas system. The non-volatiles will react to form oxides which will become part of the molten glass. A more complete description of the HLW Vitrification Facility is provided in the System Descriptions section of the RPP System Plan[18].

The WTP design basis assumed that the PT Facility will provide some of the support infrastructure necessary to operate the HLW Vitrification Facility (e.g., control room, incident command post, and SC emergency electrical power and compressed air). Since the PT Facility will not be completed in Alternative 18, the baseline design of the HLW Vitrification Facility will need to be revised to include the SSCs to allow the facility to operate independently. Additionally, the baseline design for the HLW Vitrification Facility did not include sufficient space for assembly of replacement melters or for shipping solid waste. An engineering study[51] was performed to determine the necessary modifications to the HLW Vitrification Facility to provide the necessary infrastructure for independent operation and to add a Melter Assembly Building and an Import/Export Dock.

It is assumed that the HLW melters installed for initial startup of the HLW Vitrification Facility will have a design capacity of 3.0 MTG/day each. Once the melters reach their design life, they will be replaced with upgraded melters with a design capacity of 3.75 MTG/day each.

The liquid effluents from the HLW Vitrification Facility will be collected in RLD-VSL-00007. After chemistry adjustments, the effluent will be transferred to RLD-VSL-00008. It is assumed that modifications will be required to the RLD system to pump or gravity drain RLD-VSL-00008 to the HLW Effluent Collection Vessel in the WTV.

4.2.10 IHS FACILITY

The IHS will be needed once the HLW Vitrification Facility starts up in 1/2034 to receive and store immobilized high-level waste (IHLW) canisters that will be produced at the HLW Vitrification Facility. As described in Section 10 of Appendix B of the AoA Report and in the IHS Conceptual Design Report[27], the IHS design includes two storage vaults, each with a capacity of 2,016 IHLW canisters.

For purposes of the AoA, the AoA team assumed that shipment of IHLW canisters to the off-site geological repository will begin in calendar year 2034. The IHS Facility conceptual design provides storage space for 4,032 IHLW canisters. Since HLW vitrification is planned to start immediately after completing hot commissioning of the HLW Vitrification Facility in

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[51] Engineering Study to Provide ROM Cost Estimate and Conceptual Development of HLW Options E and F (Equipment Import/Export Routes), 2016, 24590-HLW-ES-ENG-15-006, Rev. 0,

2033[52], the planned IHS Facility will only be required to store the number of IHLW canisters that could be generated in one year. Since the maximum IHLW canister production rate for any alternative is approximately 1,200 per year, the IHS design storage capacity far exceeds the minimum required capacity.

4.3 Phase 2 Facilities

The Phase 2 processing operations rely in part on the same processing facilities that are used in Phases 1 and 1B. LAW characterization, staging, pretreatment, vitrification, and effluent management in the East Area will continue operations in parallel. Phase 2 will add an LFE to concentrate the Pretreated LAW. An OSGF will also be added in Phase 2 to provide the capability to grout the excess LAW (referred to as supplemental LAW treatment) that cannot be vitrified in the LAW Vitrification Facility. The PFNW and WCS facilities will not be used in Phase 2. Instead, the pretreated LAW from the West Area will be transferred to AP-106 via the SY Farm and AP Farm LILO Stations to allow treatment (grouting) in the OSGF. Additionally, Phase 2 will require East and West Area WRFs to facilitate retrieval of the NE and NW Quadrant SSTs.

Except for the ETF, none of the Phase 1B facilities will require modifications during Phase 2. These facilities will continue to operate in parallel as a combined flowsheet. As discussed in Section 3.3.18 of this Addendum, the existing ETF will not have sufficient capacity to treat the process condensate generated in Phase 2. In addition to having an inadequate treatment capacity, the existing ETF will have far exceeded its design life by the time Phase 2 starts. For these reasons, the AoA team concluded that the existing ETF would need to be replaced with a higher capacity facility no later than 12/2050.

Phase 2 will also require several new higher capacity pretreatment and treatment facilities to achieve the higher LAW and HLW processing rates that will enable completion of tank waste treatment by 6/2075. The following subsections describe the new (e.g., LFE, OSGF, and ETF) facilities that are needed for Phase 2.

4.3.1 NE QUADRANT SINGLE SHELL TANKS

The SSTs in the NE Quadrant will include the SSTs located in the B complex (B, BX, and BY Tank Farms). The B complex is located too far from the SE Quadrant Tank Farms to allow transfer of the retrieved waste directly to a DST via HIHTLs. The East Area WRF project scope of work will include storage tanks/vessels and below-grade pipe-in-pipe waste transfer lines and associated pump and valve pits to facilitate retrieval of the B complex SSTs to a designated DST(s) in the SE Quadrant.

Eleven SSTs in the B and T complexes were determined to contain potential contact-handled transuranic (CH-TRU) waste. There are four B complex SSTs containing potential CH-TRU sludge: Tanks B-201, B-202, B-203, and B-204. If the waste is determined to be CH-TRU, ORP intends to retrieve and treat this waste using a separate CH-TRU waste treatment process.

4.3.2 EAST AREA WRF

Phase 2 will require a new 200 East Area WRF to facilitate retrieval of the B complex SSTs. The Mission Analysis Report for the East Area WRF[26] describes the required functional capabilities to support SST retrieval, including receipt and storage of supernate and slurries retrieved from the SSTs, recycling of supernate for waste mobilization, and routing of waste to the DST system.

A subsequent engineering study[53] in 2010 evaluated alternatives for the location, tank sizing, and vault configurations for the 200 East Area WRF and added functional requirements for WFD of tank sludge. The 2010 engineering study and the RPP System Plan[18] provide more specific information on the proposed architecture (e.g., facility layout including waste storage vessels and transfer lines) for the East Area WRF. The 2010 engineering study recommended that the East

[52] In the unconstrained funding case, it is assumed that hot commissioning of the HLW Vitrification Facility will be completed by 12/31/2033 as specified in the ACD.
[53] East Area Waste Retrieval Facility Location and Tank Configuration Study, 2010, RPP-RPT-45955, Rev. 0

Area WRF design should include four vessels, each with a working volume of 160 kilogallons (kgal) and a capacity of 180 kgal. It also recommended that these vessels be housed in a below-grade concrete vault located adjacent to B Complex.

The AoA team assumed that the functional capabilities of the East WRF will be limited to transfer of retrieved waste from the B complex SSTs, storage of the retrieved bulk slurry, and transfer of the bulk slurry to a designated DST in the SE Quadrant. The WRF tanks/vessels are assumed to provide the capability for mixing, solids settling, and decanting. The bulk slurry remaining in the WRF tanks/vessels will be transferred to a designated DST in the SE Quadrant for sampling and characterization.

4.3.3 HFPEM FACILITY

During Phase 1B, the HLW processing facilities that are needed to increase the processing capacity for Phase 2 will be completed. The HLW pretreatment and effluent processing capacities will be increased by the addition of a new HFPEM Facility, and the LAW treatment capacity is increased by the addition of the OSGF.

4.3.3.1 HFPEM Facility Design

Section 6 of Appendix B of the AoA Report describes the pre-conceptual HFPEM Facility design features and configuration. Based on the MAR and high-solids concentration in some process vessels it is assumed that the HFPEM Facility would be a Hazard Category 2 facility and that the primary and secondary containment SSCs would be designed to Seismic Category I requirements for NPH protection. The facility safety basis is assumed to include SS or SC active vessel ventilation, vessel air sparging, and active confinement ventilation. Other design features are discussed in Section 6 of Appendix B of the AoA Report.

The Alternative 18 HLW process rates were evaluated and determined to require HFPEM Facility resizing as discussed in Section 4.3.3.2 in this Addendum. Figure 9 and Figure 10 show pre-conceptual plan and section (or elevation) views after resizing the HFPEM Facility for Alternative 18, respectively. Figure 11 shows the proposed sites of the HFPEM Facility, LFE Facility, and WTV Facility for Alternative 18. The following process function description is provided to aid in understanding the functions of the different vessels shown on the HFPEM Facility plan and section figures.

Section 5.2 for Alternative 14 in Appendix A of the AoA Report discusses the HFPEM process functions that will include solids/liquid separation, filtration, caustic leaching, solids washing, and feed concentration that are performed in HFPVs and Filter Feed Vessels (FFVs). The supernate in the FFV(s) will be recirculated through a cross-flow filter. The dilute liquid permeate will be sent to one of the HLW Evaporator Feed Vessels. Concentrated permeate will be sent to one of the four HLW Evaporator Concentrate Vessels and ultimately returned to the SE Quadrant DST system. As the slurry is recirculated in the filtration loop, the solids concentration of the filter feed will increase. Once the concentration of the solids reaches nominally 15 wt %, the slurry will be transferred to one of the two HFVs. The slurry in the HFPVs will be blended with the slurry from the FFVs in the HFVs. The combined slurry will be staged in the HFVs for delivery to the HLW Vitrification Facility.

4.3.3.2 HFPEM Facility Resizing for Alternative 18

For Alternative 18, the AoA team chose to assume that the HFPEM Facility would provide the same pretreatment and effluent processing capabilities provided by Alternative 14. For Alternative 14, the AoA team developed a preconceptual design basis and drawings for the HFPEM Facility. The design of the HLW pretreatment process and support areas for Alternative 14 were based in part on the design information developed for the HFPEM Facility for Alternative 2.

The AoA team resized the process vessels and process support areas for Alternative 14 based on the actual vessel and equipment sizes required to sustain the required pretreatment throughput/capacity. Since the WRPS process model assumed the same pretreatment capacity for Alternative 18 as Alternative 14, these process and process support areas were not resized for Alternative 18. The HLW effluent processing capacity for Alternative 18 is different from that of Alternative 14. The HLW evaporator process and process support area sizes were adjusted for Alternative 18 to account for the difference in capacity.

The Model Results Report[1] shows that the required evaporator process boiloff rate (capacity) for Alternative 18 is 9.7 gpm. Since the process model assumes a TOE of 40%, the required capacity for the HLW evaporator needs to account for the fact that there will be periods of time when the WTP facilities are operating at their design capacity. Table 4-3 shows the required boil-off rates (capacity) for HLW evaporators needed for Alternatives 2, 14 through 16, and 18.

The AoA team used the same methodology developed for sizing the HLW evaporator process and process support areas for Alternatives 14 through 16 to determine the size for these same areas for Alternative 18. This sizing methodology is based on the required capacity of the evaporator. This methodology is described in Sections 6.1 and 6.2 of Appendix B of the AoA Report. Using this methodology, scaling factors were developed for the HLW Evaporator Process Building and Safety System Building for Alternative 18. These scaling factors were then applied to the reference preconceptual design drawings for Alternative 2 to calculate the required building footprint. Table 8 through Table 11 provide the input data and the results for these calculations.

Table 8: Scaling Factor for HLW Evaporator Process Building

Alternative	HLW Evaporator Boiloff Rate (40% TOE; gpm)	Required HLW Evaporator Boiloff Rate (gpm)	WTP EMS Boiloff Rate (gpm)	Difference in Boiloff Rate (gpm)	Scaling Factor for HLW Evaporator Process Building
2	13.30	33.25	9.00	24.25	135%
14	10.40	26.00	9.00	17.00	94%
15	7.00	17.50	9.00	8.50	47%
16	4.10	10.25	9.00	1.25	7%
18	9.70	24.25	9.00	15.25	85%

Table 9: Sizing of the HLW Evaporator Process Building

Alternative WTP EMF Areas	WTP EMF Process Area (ft^2)	Scaling Factor for Evaporator Process Building	Additional Area Required for Evaporator Process Building (ft^2)	HLW Evaporator Process Building Area (ft^2)
2	7,800	135%	10,508	18,308
14	7,800	94%	7,367	15,167
15	7,800	47%	3,683	11,483
16	7,800	7%	542	8,342
18	7,800	85%	6,608	14,408

Table 10: Sizing of Safety System Building (using updated HLW evaporator process building size)

Alt	HFP Process Vault Area (ft^2)	HEMF Process Vault (ft^2)	HFP Waste Transfer Pit (ft^2)	Pump & Valve Pit (ft^2)	HLW Evap. Bldg (ft^2)	HLW Slurry Tank Vault (ft^2)	Total Vent Area (ft^2)	Vent. Area Included in WTP EMF (ft^2)	Scaling Factor	Sizing Factor to be applied to WTP EMF Vent. Bldg (ft^2)	WTP Vent. Bldg Effective Size (ft^2)	Scaled Safety System Bldg, Single Story (ft^2)	SSB Size for Single Story (ft^2)	Scaled Safety System Bldg, Two Story (ft^2)
2	27,452	5,840	1,500	6,460	18,308		59,560	14,156	50%	160%	7,632	19,872	19,872	9,936
14	10,430	7,648	1,500	7,960	15,167		42,705	14,156	50%	101%	7,632	15,328	15,328	7,664
15		4,924	1,530	5,660	11,483		23,597	14,156	50%	33%	7,632	10,177	10,177	5,089
16		4,924	1,530	6,120	8,342	4,982	25,898	14,156	50%	41%	7,632	10,797	10,797	5,399
18	10,430	7,648		7,960	14,408		40,446	14,156	50%	93%	7,632	14,719	14,719	7,359

Table 11: Summary of Facility Sizes by Alternative

Facility	Alternative 2 (ft²)	Alternative 14 (ft²)	Alternative 15 (ft²)	Alternative 16 (ft²)	Alternative 17 (ft²)	Alternative 18 (ft²)
HFP Process Vault/Decon Cell	27,452	10,430	NA	NA		10,430
HLW Slurry Vault	NA	NA	NA	4,982		NA
HEMF Process Vault	5,840	7,648	4,924	4,924		7,648
Waste Transfer Pit	1,500	1,500	1,530	1,530	2,000	
Pump & Valve Pit/ Decon Cell	6,460	7,960	5,660	6,120		7,960
HLW Evaporator Process Building	18,308	15,167	11,483	8,342		14,408
Safety System Building	9,936	7,664	5,089	5,399	2,000	7,359
Control & IT Room	2,000	2,500	1,500	1,400		2,500
Cold Chemical Pad	2,250	2,734	1,509	1,509		2,734
Total ft², w/o Chem Pad	**71,496**	**52,869**	**30,186**	**32,697**	**4,000**	**50,305**

Figure 9 and Figure 10 show pre-conceptual plan and section and elevation views after resizing the HFPEM Facility for Alternative 18. Figure 11 shows the proposed sites for the HFPEM Facility for Alternative 18 in relation to the WTP facility locations.

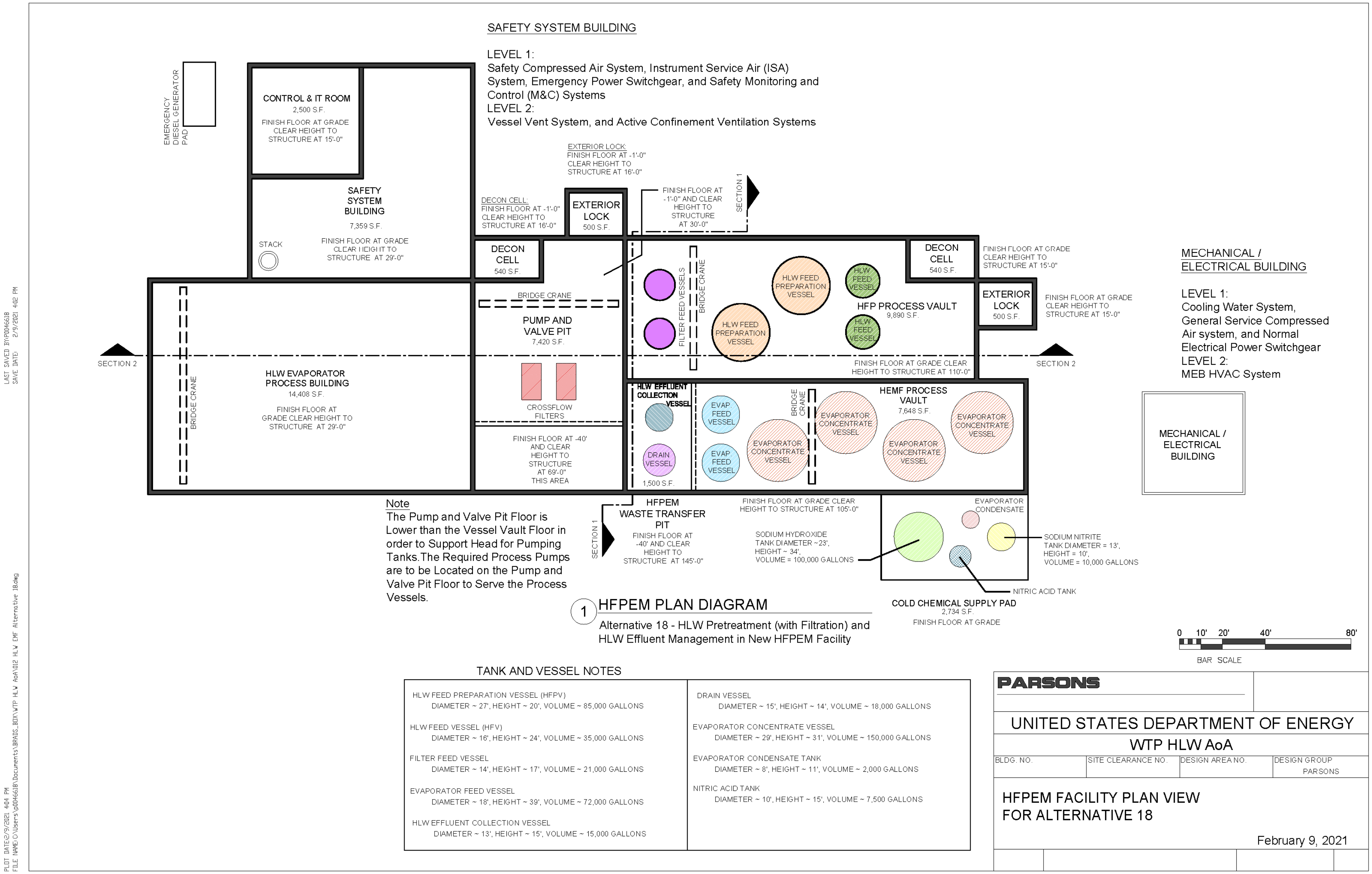

Figure 9: Alternative 18 HFPEM Facility Plan Diagram

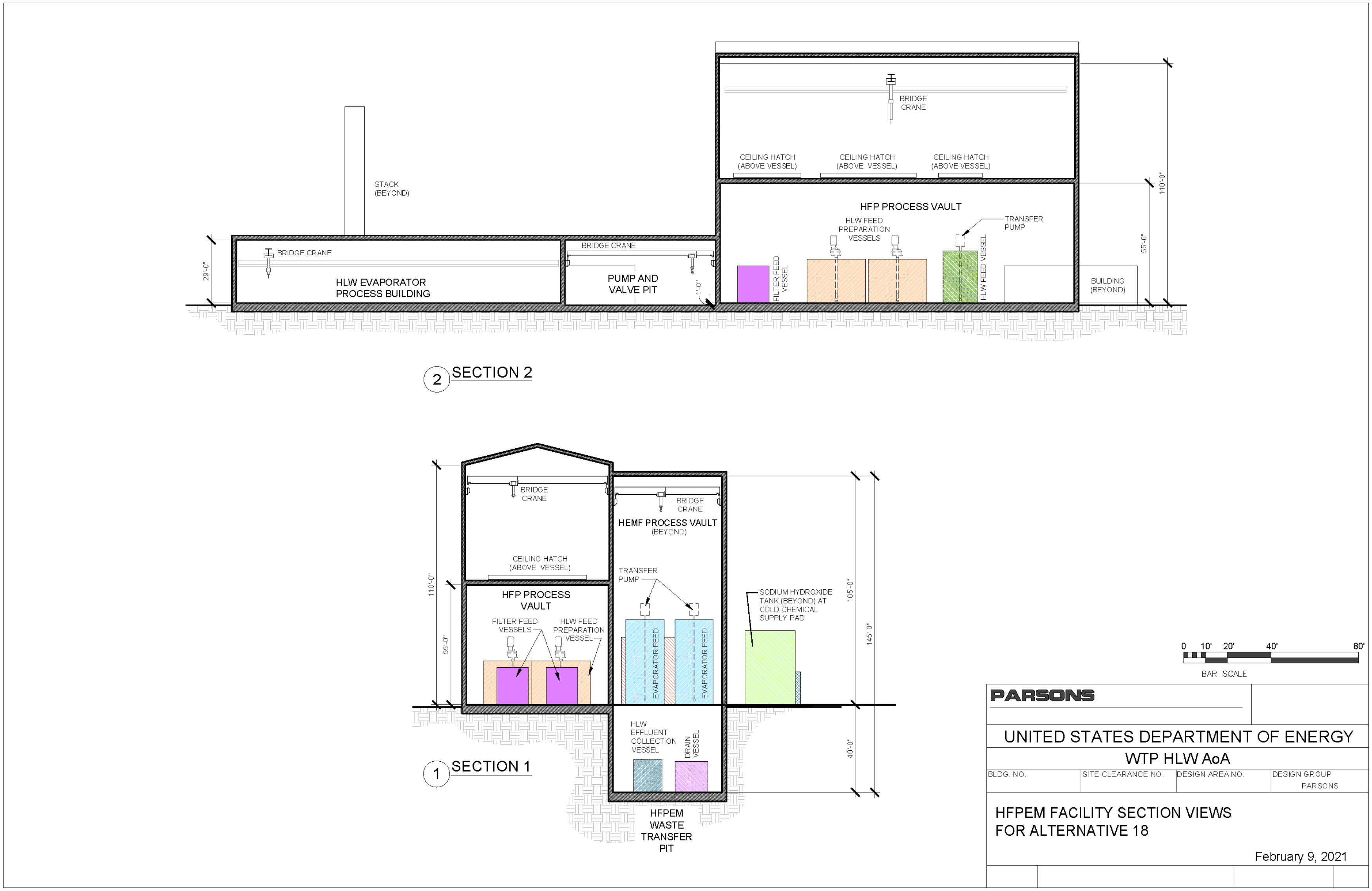

Figure 10: Alternative 18 HFPEM Facility Elevation Diagram

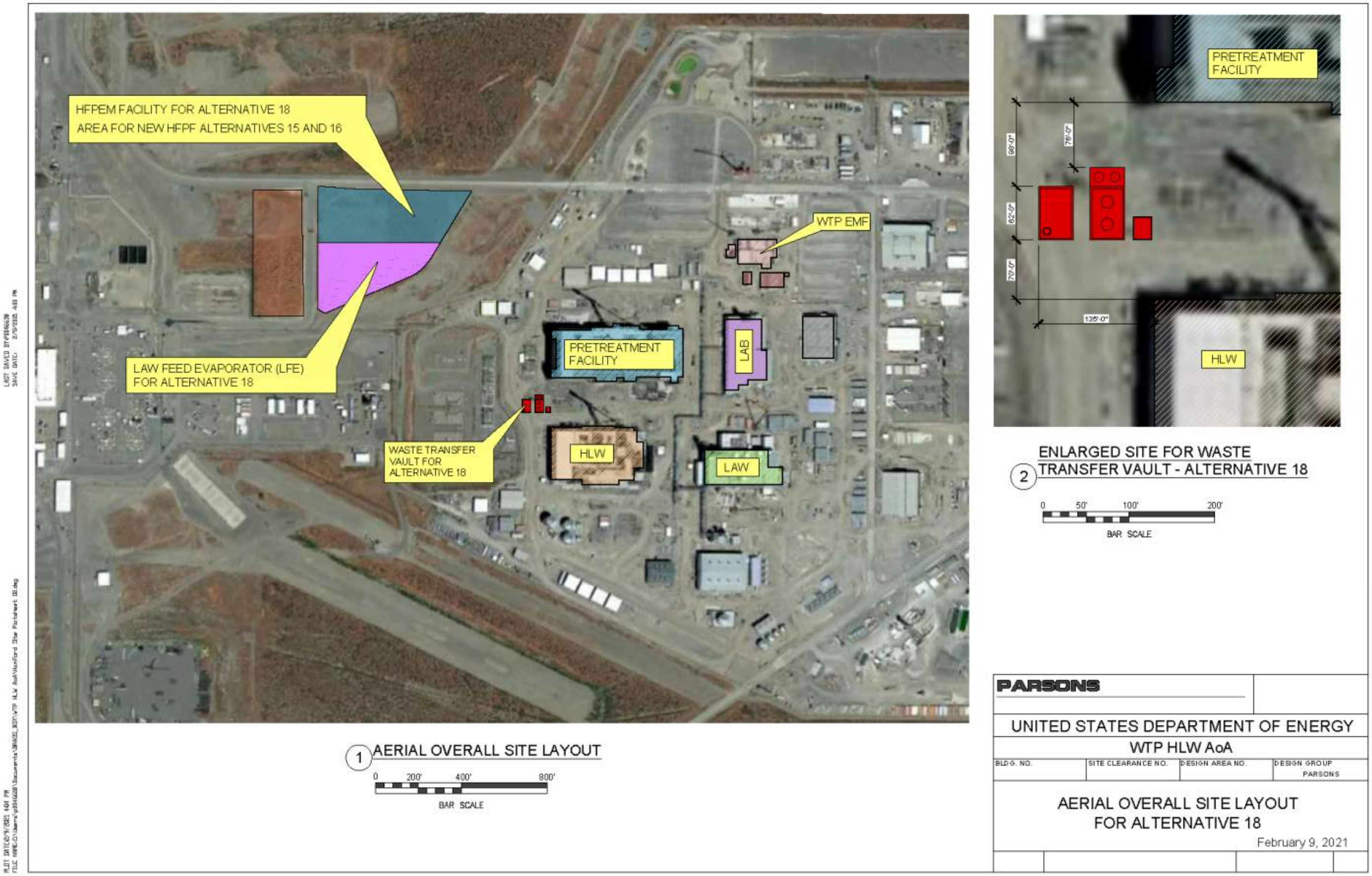

Figure 11: Alternative 18 Proposed Sites for HFPEM, LFE, and WTV Facilities

4.3.4 LFE FACILITY

An LFE Facility must be constructed during Phase 1B for use in Phase 2 of Alternative 18. The Alternative 18 LFE Facility will concentrate pretreated LAW supernate received from AP-106 before transfer to the LAW Vitrification Facility or OSGF. Section 3.9 in Appendix A of the AoA Report describes the need for a LFE Facility to concentrate the LAW feed once retrieval of the high-phosphate LAW SSTs (B and T complexes) begins. To prevent the reprecipitation of phosphate in the pretreated LAW, the feed will be kept dilute during retrieval and pretreatment of supernate from the B and T complex SSTs.

4.3.4.1 LFE Facility Design

Section 11.5 of Appendix B of the AoA Report describes the pre-conceptual LFE Facility design features and configuration. Process operations for the LFE Facility are similar to the WTP EMF (described in Section 4.1.7 of this Addendum). The principal difference between the facilities is that the LFE will concentrate LAW rather than liquid effluents. As a result, the MAR for the LFE is significantly higher than that for the WTP EMF, and that is expected to translate into the need for SS and SDC-2 active and passive confinement systems.

The LFE Facility pre-conceptual drawings were developed using a configuration and orientation of buildings and areas similar to the WTP EMF, with revisions as needed to reflect LFE Facility Natural Phenomena Hazard (NPH) protection and remote operation and maintenance (O&M) capabilities. The LFE Facility pre-conceptual design configuration includes:

- LAW evaporator and evaporator process equipment located in grade-level Evaporator Process Area
- Evaporator Concentrate Vessels located in a grade-level Evaporator Concentrate Area
- LAW Effluent Collection Vessel and Evaporator Drain Vessel located in a below-grade Waste Transfer Pit

All the above structures are assumed to be designed to Seismic Category II requirements and constructed of reinforced concrete. The structures share interconnecting walls and are configured to simplify waste routing. The ventilation and process support systems are assumed to be in a separate Ventilation and Process Support Building. Since the MAR is low in comparison to the HFPEM, these systems are expected to be Seismic Category I. A separate non-safety mechanical and electrical building houses the utility systems.

Similar to the WTP EMF, the LFE Facility will consist of a main building with a Process Area, Concentrate Tank Area, Drain Tank Area, Condensate Tank Area, Utility Building, Electrical Building, Stack, and a Truck Bay. The Process Area contains two sections, one for the Evaporator and Reboiler and one for the Condenser and process ventilation. An ‘Evaporator Area’ and a ‘Process Area’ are shown in the WTP EMF drawings. Each of these areas include space for pumps.

The Alternative 18 HLW process rates were evaluated and determined to require LFE Facility resizing as discussed in Section 4.3.4.2 of this Addendum. Section 11.5 of Appendix B of the AoA Report developed a preconceptual design basis and drawings for the LFE Facility. Figure 9 and Figure 10 show similar LFE Facility pre-conceptual plan and section (or elevation) views after resizing the LFE Facility for Alternative 18.

4.3.4.2 LFE Facility Resizing for Alternative 18

Alternatives 2, 14, 15, and 16 each included a separate LFE Facility to concentrate the pretreated LAW Feed from the TSCR and TFPT facilities since the PT Facility was not used. The LFE Facility size was scaled for each of these alternatives based on evaluation of required evaporative process rates. The AoA team resized the Alternative 18 LFE Facility process vessels and process support areas in a similar manner based on the actual vessel and equipment sizes required to sustain the evaporator processing throughput/capacity.

The Model Results Report[1] shows that the required evaporator process boiloff rate (capacity) for the LFE for Alternative 18 is 9.9 gpm. Since the process model assumes a TOE of 40%, the required capacity for the LFE should be adjusted to account for the fact that there will be periods of time when the LAW treatment facilities will operate at their full capacity. After making this adjustment, the required LFE capacity for Alternative 18 is 25 gpm.

Section 11.5 of Appendix B of the AoA Report describes the methodology the AoA team used in developing pre-conceptual drawings and building dimensions for the LFE Facility areas by scaling the similar WTP EMF areas based on the difference in the evaporator process boiloff rates.

Using the methodology described in Section 11.5 of Appendix B of the AoA Report, the scaling factor for determining the size of the LFE Facility for Alternative 18 is 5% as shown in Table 12. Using this scaling factor, Table 13 shows the predicted size of the LFE Facility as 26,204 ft^2.

Table 12: Scaling Factor for LFE Facility

Alternative	LAW Feed Boiloff Rate (gpm)	WTP EMF Boiloff Rate (gpm)	Ratio LAW Feed to WTP EMF	LFE Scaling Factor
2	14.7	9	1.63	32%
14	12.9	9	1.43	22%
15	14.6	9	1.62	31%
16	15.3	9	1.70	35%
18	9.9	9	1.10	5%

Table 13: Sizing of LFE Facility for Alternative 18 Using Scaling Factor

WTP EMF Areas	East/West Dimension (ft)	North/South Dimension (ft)	WTP EMF Area Size (ft^2)	Scaling Factor for LFE	Additional Size Needed for LFE (ft^2)	LFE Area Size (ft^2)
Evaporator Area	60	65	3,900	5%	195	4,095
Process Area	100	65	6,500	5%	325	6,825
Evaporator Concentrate Area	40	47	1,880	5%	94	1,974
North Area (East of Evap. Concentrate Vessels)	120	47	5,640	-100%	(5,640)	
Utility Area	94	74	6,956	5%	348	7,304
Stack Area	26	26	676	0%		676
Air Handling Unit Area	76	24	1,824	5%	91	1,915
Anti-Foaming Reagent Area	12	12	144	5%	7	151
Electrical Building	53	36	1,908	5%	95	2,003
Drain Tank/Waste Transfer Pit	30	40	1,200	5%	60	1,260
Total Area (ft^2)			**30,628**		**(4,424)**	**26,204**

Table 14: Summary of LFE Facility Sizing by Alternative

WTP EMF Areas	Alt 2 (ft^2)	Alt 14 (ft^2)	Alt 15 (ft^2)	Alt 16 (ft^2)	Alt 18 (ft^2)
Evaporator Area	5,135	4,745	5,113	5,265	4,095
Process Area	8,558	7,908	8,522	8,775	6,825
Evaporator Concentrate Area	2,475	2,287	2,465	2,538	1,974
North Area (East of Evap. Concentrate Vessels)					
Utility Area	9,159	8,463	9,120	9,391	7,304
Stack Area	676	676	676	676	676
Air Handling Unit Area	2,408	2,219	2,391	2,462	1,915
Anti-Foaming Reagent Area	190	175	189	194	151
Electrical Building	2,512	2,321	2,502	2,576	2,003
Drain Tank/Waste Transfer Pit	1,580	1,460	1,573	1,620	1,260
Total Area (ft^2)	**32,693**	**30,256**	**32,552**	**33,497**	**26,204**

Table 14 summarized the LFE Facility sizes for Alternatives 2, 14, 15, 16, and 18. Figure 12 and Figure 13, respectively, show preconceptual plan and elevation views after resizing the LFE Facility for Alternative 18.

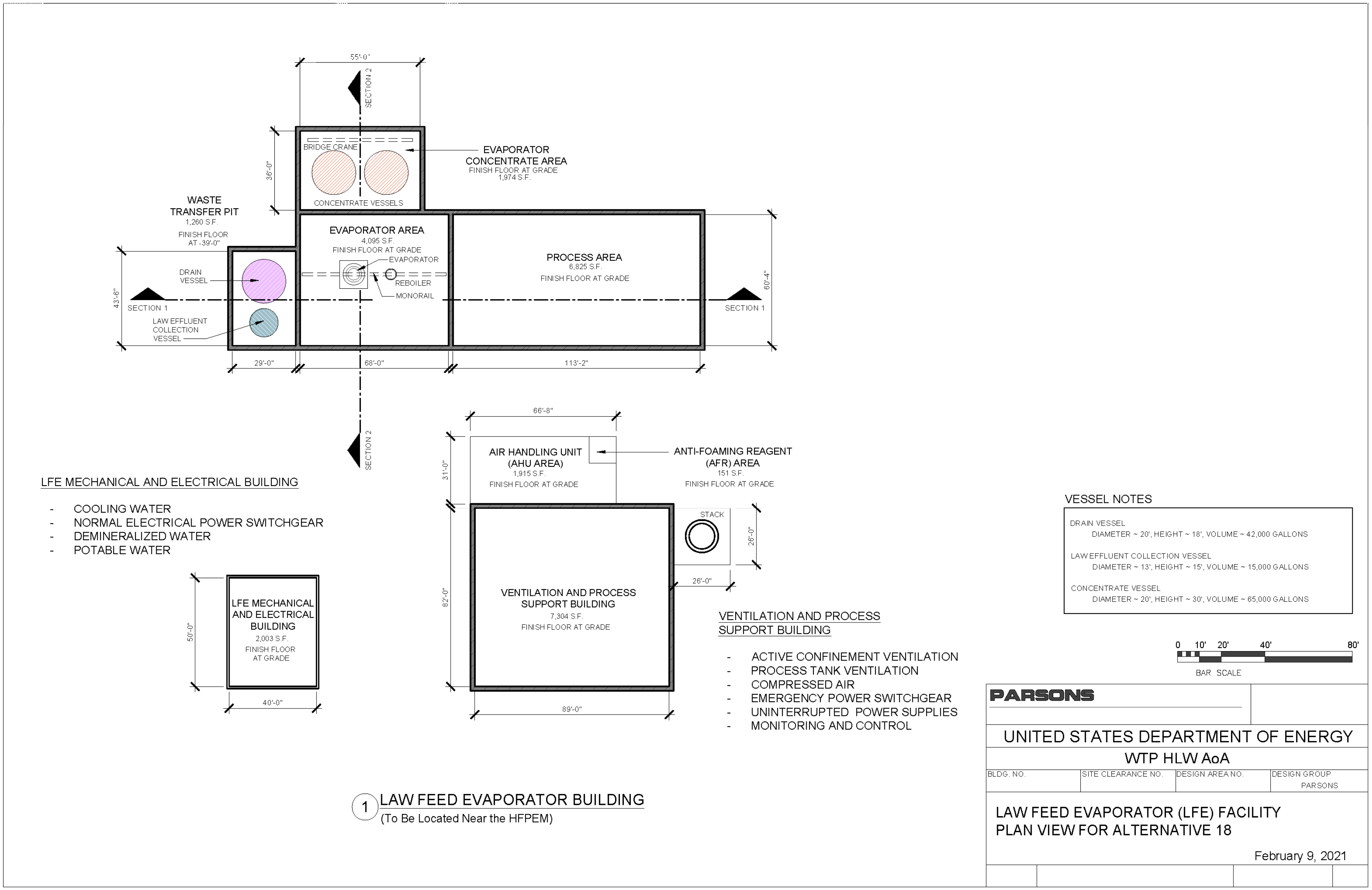

Figure 12: Alternative 18 LFE Facility Plan Diagram

PARSONS

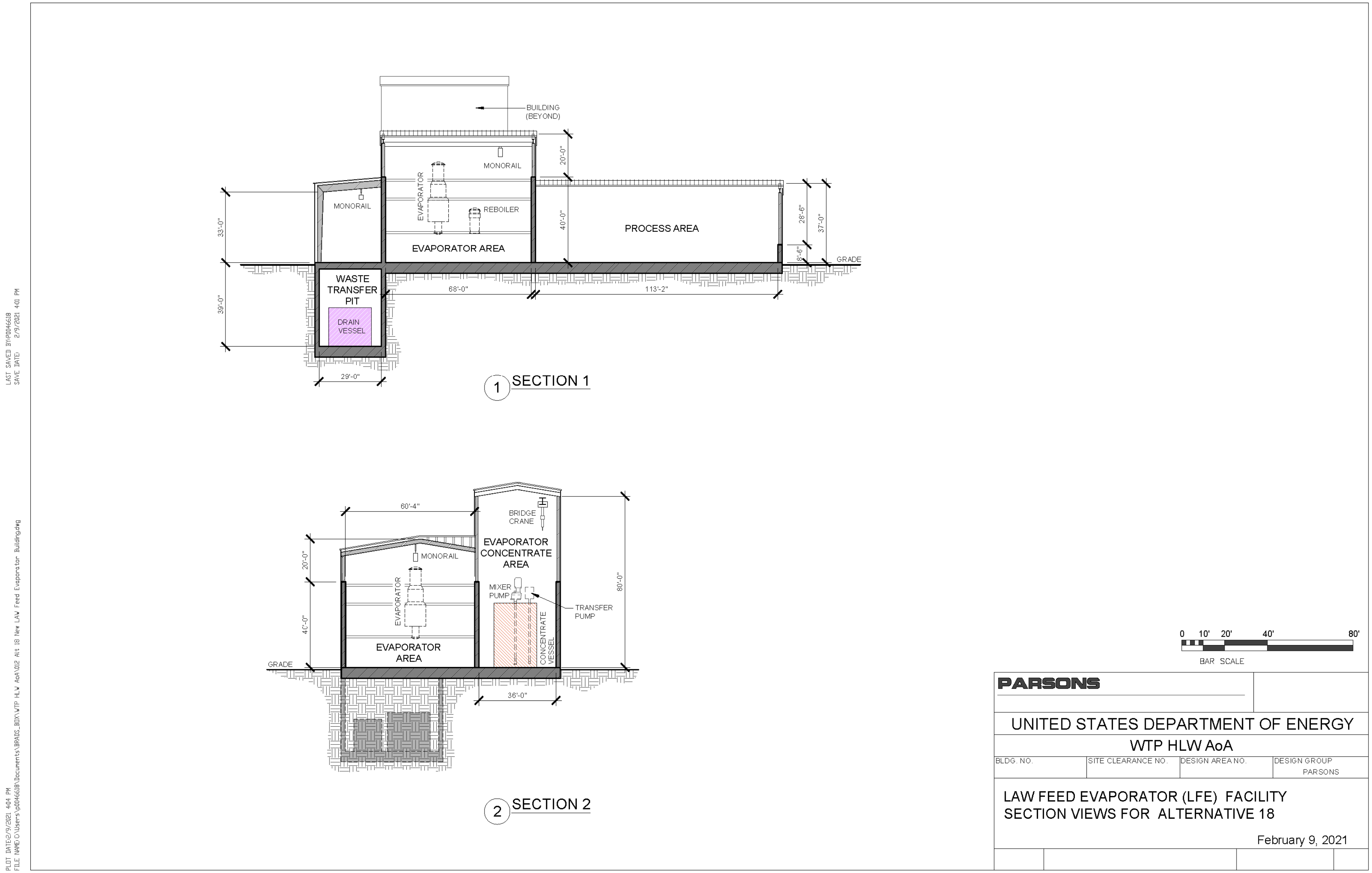

Figure 13: Alternative 18 LFE Facility Elevation Diagram

4.3.5 ON-SITE GROUT FACILITY

The OSGF is assumed to use processes and equipment that are the same as those for the WSU described in the SLWT Conceptual Design Report (CDR)[33]. The planning basis for the ETF evaporator has evolved since the SLWT conceptual design was completed, and the current acquisition strategy is based on a vendor designed modular grout system (MGS). Since all grout microencapsulation processes use similar processes and equipment, using the WSU (or MGS) design as the reference point for determining the capital/operating costs or technical risks for the OSGF is expected to provide similar results.

The SLWT CDR provided conceptual level design, cost, and schedule details for the WSU, whereas the MGS concept is based only on a design specification[54]. Since the WSU design was developed to a higher level of detail than the MGS, the AoA team chose to use the WSU as the reference design for the OSGF.

The AoA team assumes the OSGF would be located near the AP Farm to simplify LAW routing during Phase 2 operations. The LFE will concentrate pretreated LAW supernate received from AP-106 and transfer this concentrated product to either the LAW Vitrification Facility or the OSGF. The OSGF will operate in Phase 2 to treat residual LAW that is generated in excess of the capacity of the LAW Vitrification Facility.

4.3.5.1 OSGF Capacity and Sizing

The OSGF size was determined by scaling up from the WSU building sizes based on the differences in capacities. The WSU as described in the SLWT CDR was used as a starting point to determine the required OSGF process equipment, process and utility support systems, and the buildings and structures needed. The number of OSGF process lines and relative size of the equipment and Process and Solidified Waste Storage Buildings were estimated by determining the difference in process rates (capacity) and then using engineering judgment to apply scaling factors. The calculational methodology is provided below.

- Since the brine from the ETF evaporator will be fed to the WSU (more recently referred to as the Modular Grout Unit), the brine production rate is the same as the feed rate to the WSU or to the Modular Grout Unit.
- The brine production rate is a function of the organic concentrations in the ETF feed. “Case 3,” as described in CDR Table 4-1, assumes a worst-case organic concentration that results in a higher brine production rate (2.2 gpm). CDR “Case 4” assumes an average value of organics and results in a lower brine production rate (1.3 gpm).
- CDR Table 6-2 shows that the flow rate to the WSU is 3.2 gpm if the composition of the process condensate being fed to the ETF is the same as predicted by the Aspen model.
- At a feed rate of 3.2 gpm, four ¼-height ISO (International Standard Organization) containers (292 cubic feet) are filled each day assuming that the WSU operates 24 hours/day.
- The WRPS process modeling was based on treating the LAW that was designated for LAWST in an OSGF during Phase 2. The process model also assumed that treatment of the LAW from the West Area would continue at an off-site grout facility (PFNW) throughout Phases 1B and 2. Subsequent to completion of the modeling, ORP agreed that it would be more cost effective to treat all of the supplemental LAW and the West Area LAW at the OSGF during Phase 2.
- Based on the process modeling results, the maximum combined annual volume of Supplemental LAW and West Area LAW that will need to be treated at the OSGF is 4.91 Mgal (at 40% TOE). This OSGF peak demand occurs in 2051.
- To determine the required OSGF capacity it is assumed that all the Tank Farm and WTP facilities operate at 100% TOE for the year 2051.
- It is also assumed that the OSGF facility availability will be 70%.
- The required OSGF capacity is therefore 17.5 Mgal/year or 33.3 gpm.
- The capacity scaling factor from the WSU to the OSGF is 10.5 (33.3 gpm/3.2 gpm).

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[54] Specification for the Modular Grouting System for Treatment of EMF Brine (Project OP187), 2020, RPP-SPEC-64252, Rev. 0

4.3.5.2 Treatment Capacity

The WRPS Process modeling results[1] show that the highest volume of LAW that the OSGF would have to process in any year is 4.91 Mgal. This occurs in 2051. The WRPS model results are based on a TOE of 40% for the tank farm and WTP facilities. For purposes of designing the OSGF, the tank farm and WTP facilities are assumed to operate at full capacity during year 2051. This provides a conservative estimate for the worst-case feed rate (and required capacity) for the OSGF.

The worst-case volume of LAW feed that would be sent to the OSGF is therefore 4.91 Mgal/.4 = 12.3 Mgal. The OSGF would have to sustain a treatment rate of 23.3 gpm for the entire year to keep pace with HLW treatment. For purposes of determining the design capacity for the OSGF, an average availability (or TOE) of 70% was assumed. The "design capacity" for the OSGF is then 23.3 gpm/.7 = 33.3 gpm.

To determine the required size for the OSGF, the footprint of the WSU was increased to account for the higher capacity of the OSGF. Although some process efficiencies can usually be achieved by increasing capacity, in the case of the relatively simple batch-wise grout process that is assumed for the OSGF, the AoA team assumed that the ratio of facility footprint to capacity for the OSGF would be the same as the WSU. Since the capacity of the OSGF is 10 times that of the WSU, the sizes (footprints) of the OSGF Process and Solidified Waste Storage Buildings for the OSGF are therefore assumed to be 10 times the size of the WSU buildings. The footprints for the Process and Solidified Waste Storage Building for the OSGF are then 350,000 $ft^2$and and 280,000 ft^2, respectively.

4.3.5.3 Safety Functions and Engineered Controls

The OSGF will receive feed from the LFE. The AoA team assumed that the OSGF would include several small (100 kgal) vessels to provide feed staging and a surge capacity to allow the OSGF to continue to operate in the event of a short-term LFE Facility outage. These vessels will contain the bulk of the dispersible radioactive materials within the OSGF. The concentration of the radioactive materials and hazardous chemicals present in these vessels and the volume of the vessels will dictate the facility Hazard Category and the potential exposure consequences in the event of an accident. The accident exposure calculations in turn dictate the need for engineered controls to mitigate the exposure. The radioactive material at risk inventory will dictate the Hazard Category. The Hazard Category determines the breadth and depth of the accident analyses and safety basis documentation for the facility.

The LFE concentrates the feed before the pretreated LAW is grouted in the OSGF. Since the LFE is not yet designed, the radioactive and chemical constituents of the OSGF feed are unknown. As a conservative measure, it is assumed that the facility would be classified as Hazard Category 2 and that engineered controls would be required for protection of co-located workers and/or facility workers. The engineered controls are assumed to include vessel and mixer ventilation, active confinement ventilation exhaust for the Process Building, backup electrical power and monitoring and control for safe shutdown, and NPH protection including Seismic Category 2 design for the Process Building.

4.3.5.4 OSGF - Liquid Feed Staging

The LFE Facility described in Section 4.3.4 of this Addendum concentrates pretreated LAW supernate before transfer to the OSGF. Potential for LFE Facility outage requires the OSGF design include a sufficient storage capacity within the LAW concentrate receipt vessels in the OSGF to allow operation of the OSGF during short-term LFE Facility outages. The AoA team assumes an engineering study would be required to determine the feed storage/staging vessels needed to accommodate an assumed LFE Facility outage duration.

4.3.5.5 OSGF – Solidified Waste Form Selection and Mixing and Storage Configuration

Section 3.3.30.1 of this Addendum describes the evaluation of three viable waste form technologies: cast stone, Ceramicrete, and DuraLith. A TRA was performed for each technology followed by a VE study process that selected cast stone as the preferred waste form for treating the liquid effluents from tank farm and WTP facilities. Cast stone is a cementitious waste form that is produced by mixing concentrated secondary liquid waste with a dry blend mixture of Portland cement, blast furnace slag, and fly ash.

Another alternative analysis was performed to select a mixing and storage configuration for the WSU. The results of this alternative analysis were documented in RPP-RPT-51771[55]. The alternative that was selected was a ¼-height ISO container with horizontal ribbon-style mixer.

The above alternative analyses and VE study were completed in the 2012 timeframe. In 2020, WRPS developed an MGS design specification[54] that identifies the waste feed characteristics and design requirements and allows the vendor to select the waste form and mixing and storage configuration during design development.

4.3.5.6 OSGF Process Area and Major Equipment

A detailed discussion of the OSGF process flow is provided in Section 3.3.30 of this Addendum. The OSGF process area is based on the WSU design and is sized to accommodate the mechanical equipment and work space necessary to:

- Mix and fill grout containers in a two-line operation
- Hold containers for grout set-up
- Convey filled containers at the end of an off-loading area for removing the containers by forklift

Accessory spaces to the process area include rooms for electrical equipment, mechanical pumps, a large receiving tank, batch tanks and feed hoppers located in a mechanical penthouse, and mixers located on a mezzanine. Some of the main OSGF (based on the WSU design) process system equipment is described in paragraphs that follow. Other process systems are discussed in separate sections of this Addendum and include raw material metering/weighing and pneumatic transfer, mixing and blending, container filling, and container conveying. Other major OSGF systems and equipment include pumps and tanks, conveyor systems, cranes, electrical, heating/ventilation/air conditioning (HVAC), support systems (e.g., fire suppression [raw] water, sanitary [potable] water, sanitary sewer effluent, septic, and leach field), confinement zones, and nitrogen system.

4.3.6 NEW HIGHER CAPACITY ETF

For Phase 2, the process modeling results show that the highest volume of process condensate that is generated in any given year is 22.5 Mgal, assuming the processing facilities operate at an overall TOE of 40%[22]. As for Phases 1 and 1B, the leachate production rate during Phase 2 is assumed to remain constant at 1.8 Mgal/year. After adjusting the process condensate generation rate to reflect a TOE of 100% and adding the leachate generation rate, the maximum annual volume that the ETF will need to process during Phase 2 is 57.9 Mgal.

Based on the above, the maximum processing rate that the ETF will need to sustain in any year during Phase 2 is 110 gpm. To sustain this treatment rate, the ETF design capacity would have to be higher. As described in the ETF Flowsheet Assessment[21], the ETF is expected to have an overall facility availability of 70% once the modifications that are in progress (see Section 4.1.8 of this Addendum) are completed. Assuming a long-term sustained treatment rate of 110 gpm and a facility availability of 70%, the ETF would have to have a design treatment capacity of 157 gpm. This required treatment capacity is much higher than the current ETF design treatment capacity of 100 gpm.

The AoA team concluded that modifying the existing ETF to increase the treatment capacity by more than 50% would require installation of all new higher capacity process systems and tankage and a new Process Building annex to house this additional equipment. It was judged that performing these significant modifications would cost more than constructing a new, higher capacity ETF.

4.3.7 NW QUADRANT SINGLE SHELL TANKS

The NW Quadrant SSTs include the SSTs located in T, TX, and TY Tank Farms (T complex). Retrieval of the SSTs in T complex begins after retrieval of the SW Quadrant SSTs is completed in 2055. Because the T complex is located too far from the SY Tank Farm to allow use of HIHTLs, a West Area WRF will be required. The WRF will include storage vessels, pipe-in-pipe waste transfer lines, and the associated infrastructure to receive waste retrieved from the SSTs in T complex and transfer it to SY-102 or SY-103.

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[55] RPP-RPT-51771, Secondary Liquid Waste Treatment Project Alternatives Analysis Report

Eleven SSTs in B and T complexes may be determined to contain potential CH-TRU waste[18]. The SSTs in T complex that potentially contain CH-TRU sludge include Tanks T-202, T-203, T-204, T-111, T-110, and T-104. If the waste is determined to be CH-TRU, ORP intends to retrieve and treat this waste using a separate CH-TRU waste treatment process.

4.3.8 WEST AREA WRF

Phase 2 requires a 200 West Area WRF be constructed near the T Tank Farm complex to facilitate retrieval of NW Quadrant SSTs (T, TX, and TY) similar to the one installed in the East Area near the B Tank Farm complex as discussed in Section 4.3.2 of this Addendum. Section 2.4 in Appendix A of the AoA Report describes WRFs and how they will provide the required functional capabilities to support SST retrieval. The WFD-WRF Mission Analysis Report[26] further identifies functional requirements and facility architecture for the 200 East Area WRF. These functional capabilities and requirements for the 200 East Area WRF are summarized in Section 4.3.2 of this Addendum and assumed to apply similarly to the West Area WRF.

A subsequent 2010 engineering study[53] evaluated alternatives for the location, tank sizing, and vault configurations for the 200 East Area WRF and added functional requirements for WFD of tank sludge. The 2010 engineering study and the RPP System Plan[18] provide more specifics on the proposed architecture (e.g., facility layout including waste storage vessels and transfer lines) for the East Area WRF. The 2010 engineering study recommended that the East Area WRF should consist of four vessels, each with a working volume of 160 kgal and a capacity of 180 kgal. It also recommended that these vessels be housed in a below-grade concrete vault located adjacent to B complex. The AoA team assumed that the same vessel size and vault configuration recommendations would apply to the West Area WRF.

The AoA team assumed that the functional capabilities of the West Area WRF will be limited to transfer of retrieved waste from the T complex SSTs, storage of the retrieved bulk slurry, and transfer of the bulk slurry to either SY-102 or SY-103. The solid/liquid separation and mixing, sampling, and characterization functions are assumed to occur in SY-102 and SY-103.

4.3.9 AP LILO STATION

The AP Farm LILO Station is intended to be used in Phase 2 to receive a tanker truck of pretreated LAW from the SY LILO Station and transfer the tanker truck contents to AP-106. To accomplish this transfer, the AP LILO Station project will also provide HIHTLs in a new pump pit, modifications to pump and valve pits and tank risers, and a monitoring and control capability. The Function Specification for the AP LILO Station[24] provides the design requirements for the AP LILO Station.

4.3.9.1 AP LILO Station Design

The AP LILO Station waste transfer system will consist of pumps, pump pits, jumpers, valves, pipe-in-pipe transfer lines, and an interface hose connection between a vendor-supplied truck and permanently installed equipment. It will also include a weather enclosed concrete pad, an elevated access platform, a glove box for piping connections to the tanker, HVAC for the enclosure, shielding for radiation protection, and secondary containment. There will also be a Control Enclosure that houses equipment for water supply for transfer line flushes, compressed air for pressurizing the tanker, and monitoring and control (including data transmission).

The AP LILO Station project will modify the existing AP Tank Farm infrastructure to include new pipe-in-pipe waste transfer lines, underground ventilation pipe, "Drop Legs" (for waste routing through tank risers), and a new pump pit (with jumpers, valve manifold[s], waste transfer pump, leak detection, etc.). All this equipment will be SS, SDC-2, and quality level-2[24]. Piping will be designed, fabricated, and installed per American Society for Mechanical Engineers (ASME) B31.3. The project also includes control and monitoring instrumentation and associated utilities required for transferring LAW Feed from DST AP-106, to and from a tanker truck. The AP LILO Station will be sized during design. The tanker truck(s) are planned to be vendor designed and fabricated. The AP LILO Station Function Requirements Specification[24] requires that the tanker have a minimum capacity of 5,040 gallons.

Figure 14 shows the AP Farm site plan with the planned location of the AP LILO Station east of the AP Tank Farm along the 4th Street Loop.

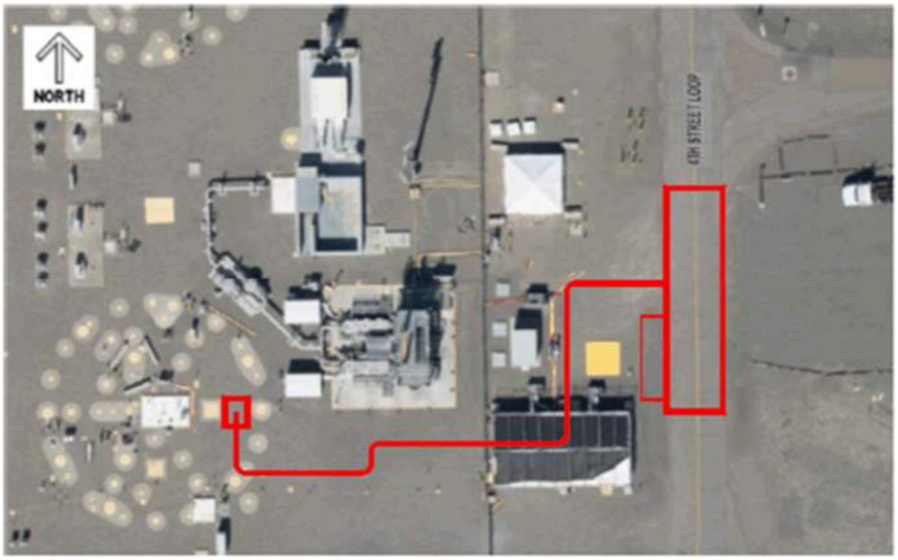


Figure 14: Site Plan for AP LILO Station

Figure 15 (copied from the PHA[45]) provides a high-level process flow for the AP LILO Station. The weather enclosure is a steel building providing a weather enclosed concrete pad designed to receive the tanker truck and facilitate making/breaking connections for waste transfers. The pad will be coated, sloped to a low point, and curbed to meet the requirements of secondary containment. During tanker loading and unloading, the truck will park on the concrete pad, and various hose connections will be made to accommodate waste transfer and pressurizing or venting the tanker. To offload the tanker, compressed air will be used to force liquid out and through the waste transfer line, into AP-106. A single waste transfer line will be used for off-loading the tanker. A separate line will be used to vent the displaced air from the tanker directly back to the AP-106 headspace.

Operators will have the capability to water-flush the system after the transfer. After the tanker has been unloaded, disconnected, and surveyed to be free from contamination, it will be released from the weather enclosure.

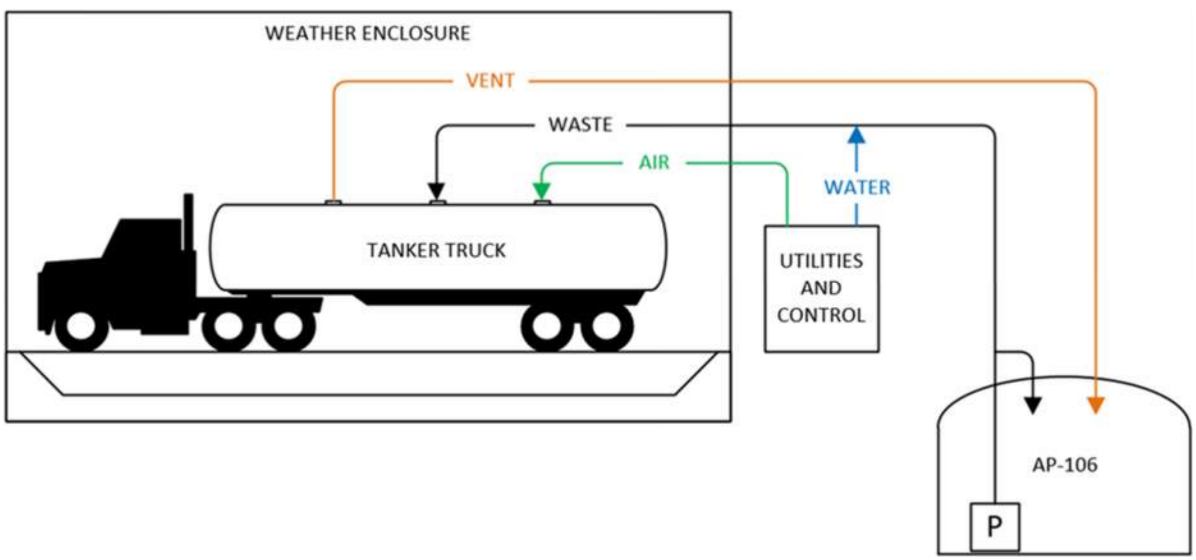


Figure 15: Conceptual Truck LILO Station Diagram

The second structure is a partitioned modular Control Enclosure (CONEX box style) consisting of an operating station (computer, closed-circuit television monitors, etc.) on one side and support equipment (e.g., water pump, air compressor) on the other. This structure will be located several feet from the steel building housing the tanker truck.

To support the transfer operation, a new valve/pump pit, buried transfer lines, transfer pump, and pipe jumpers will be installed above Tank AP-106.

4.3.9.2 AP LILO Station Safety Functions and Engineered Controls

The largest contributor to the source term for radioactive releases from untreated LAW is cesium-137. The AP TSCR process will remove the cesium from the LAW feed so the source term for radioactive releases from accidents in the AP LILO Station is relatively low.

The AP LILO Station PHA[45] does not identify the need for engineered controls to protect workers or the general public from radioactive releases due to accidents in the LILO pad and weather enclosure. Jet spray events do however pose chemical burn hazards for the facility worker. The PHA concluded that the AP LILO Station pad and weather enclosure provides a defense-in-depth function to protect the facility from jet spray events due to a seismic event. The pad and weather enclosure for the AP LILO Station are therefore designed to SDC-2 requirements.

The AP LILO Station PHA credits the underground pumps, piping, jumpers, pump pits, and nozzles, and the associated leak detection systems and components for waste confinement purposes. These SSCs are classified as SS. These SSCs also are designed to meet SDC-2 requirements to prevent seismic induced leaks.

5 Cost and Schedule Estimates

5.1 Bases of Estimates

The Lifecycle Cost Estimate (LCCE) for Alternative 18 was developed using the WRPS modeling results[1], and the scheduled costs derived from that modeling effort. The approach used is the same as that used for the initial AoA estimates, with WRPS estimates accepted or adjusted as appropriate, and necessary additions (e.g., HLW Vitrification Plant) included as appropriate.

The adjustments made to the WRPS estimated costs for Alternative 18 were consistent with the adjustments previously made for the AoA estimates for each of the other evaluated alternatives. These adjustments include:

- Adjusting costs for construction of the LFE and HFPEM based on changes in required capacity and facility footprint size
- Slightly adjusting the estimated cost of the WTV, consistent with the adjustment made for Alternative 17
- Adding a new ETF based on the required processing capacity needed for Phase 2 of Alternative 18
- Adding the cost of melter replacements during the operational life of the LAW and HLW Vitrification Facilities, similar to other alternatives
- Adjusting end-of-life D&D of new facilities, consistent with approach used for other alternatives.

The most significant change made to the WRPS model generated costs was replacing the estimated costs to construct and operate a Supplemental LAW Treatment Facility using vitrification technology with an OSGF. The basis for the OSGF construction and operating costs are described below.

5.1.1 ON-SITE GROUT FACILITY

The AoA team used the CDR and associated cost estimate developed for an SLWT Project in 2012[33], after determining that the project scope, facility design, and basis of estimate were well-defined and documented, and that the WSU facility that was part of the SLWT project closely resembled the facility that will be needed for on-site grout processing as a technology for supplemental LAW treatment for Alternative 18. The scope of the SLWT project included some ETF modifications, but a review of the cost estimate details[56] found that the cost for those elements was relatively minor compared to the overall project cost. Furthermore, the AoA team determined that the additional cost for the EFT modifications was more than offset by the additional cost associated with the engineered controls required for nuclear safety for the OSGF.

The AoA team assumed that the OSGF would be a Hazard Category 2 facility because the LAW feed is concentrated in the LFE. In comparison, the SLWT cost bases assumed that the ETF, including the WSU, would remain a Less Than Hazard Category 3 facility. The AoA team assumed that the safety analysis results will require that the OSGF include passive and active engineered controls (e.g., higher seismic category, and SS active confinement ventilation, emergency electrical power). Accordingly, it is likely the added costs for these engineered controls more than offset any reduction derived by deletion of the scope of the ETF modifications from the SLWT project cost estimate.

Although the design capacity of the SLWT was significantly lower than that required for treatment of the supplemental LAW waste stream for Phase 2 of Alternative 18, the CDR and the associated cost estimate were judged to provide a sound basis from which the OSGF construction costs could be scaled. The WSU design capacity was 3.2 gpm, or 1.7 Mgal per year. For Phase 2 of Alternative 18, the OSGF would have to sustain a treatment rate of 4.91 Mgal/year with the WTP operating at a TOE of 40%. After adjusting the TOE to 100%, and adding an appropriate design margin, the minimum required treatment capacity of the OSGF is 17.5 Mgal/year (equivalent to 33.3 gpm).

To scale the construction costs, the CDR estimated costs for Procurement and Construction were scaled up using an exponential scaling factor. Such factors are used to scale costs based on size or capacity parameters and are an accepted cost estimating practice throughout the process and power industries. The factor used is dependent on the degree of economy of scale that can be expected. Because many process facilities and equipment items have historically been shown to scale using a 0.6 exponent, this methodology is sometimes referred to as the six-tenths rule. But the actual factor can vary depending on the equipment and processes to be used and type of facility. In cases where there is a direct correlation to capacity or size with no economy of scale, the factor is 1.0. The more economy of scale to be expected, the lower the exponential scaling factor.

For the OSGF an assumed 0.8 exponential scaling factor was used to allow for some, but not significant economies of scale, using the formula:

$$Cost\ of\ OSGF = Cost\ of\ SLWT\ \times \left(\frac{33.3}{3.2}\right)^{0.8}$$

The basis for using -0.8 is the understanding that, rather than merely requiring larger vessels and components for the OSGG, the number of processing lines and the associated vessels and large components would need to be increased as well. This tends to limit the economy of scale. On the other hand, the building utilities and support systems would have a higher economy of scale. The 0.8 exponential scaling factor applied is intended to conservatively represent the expected scaling of costs to approximate the construction cost of the OSGF.

The same percentage adders as derived from the SLWT CDR estimate were included for PM, Design (Conceptual through Final), Engineering Support during Construction, Start-up/Testing/ORR, and MR/Contingency. The CDR estimated costs for Permitting and Safety Analysis were retained without adjustment. Costs were then adjusted to a FY 2018 basis for consistency in the LCCE cost model (that is base year for WRPS estimates used for the model). This consisted of escalating the 2012 base estimate values to FY 2018 at 4% per year, consistent with current DOE guidance.

Using this approach, the CDR estimate for the SLWT of $148.M (escalated cost based on CDR schedule) was adjusted/factored to derive an estimated cost for the OSGF needed for Alternative 18 of $1,061M in FY 2018 dollars.

As a check on the reasonableness of this estimate, the AoA team also applied the same scaling factor approach to the estimated total project cost (TPC) for a grout facility developed by SRNL in 2019 for LAWST at Hanford[57]. That report

[56] Conceptual Design Cost Estimate and Schedule for the Secondary Liquid Waste Treatment Project (T3W08), RPP-52753-2012, Rev 0

[57] Report of Analysis of Approaches to Supplemental Treatment of Low-Activity Waste at the Hanford Nuclear Reservation, Savannah River National Laboratory, October 2019.

included an estimated TPC for a Grout Facility of $720M in FY 2018 dollars. The facility estimated in that report was stated to have a capacity of 3 Mgal/year with single shift operations. That equates to a 12 Mgal/year facility with four shift (24/7) operations. Scaling that cost to 17.5 Mgal/year using the same formula as used for the SLWT results in an estimated cost of $974M. That appears to be close enough to add credibility to the SLWT derived cost estimate, with the latter being used for Alternative 18 as slightly more conservative and based on more detailed cost estimate data (none of which was available for the SRNL cost estimate).

For the costs to operate the OSGF, the AoA team used recent data generated based on actual operating cost of the Saltstone Facility at SRS. That information projected the annual cost to operate Saltstone on a 24/7 basis to be approximately $50M in FY 2018 dollars. With that operating approach, Saltstone would be capable of processing 11.6 Mgal per year. The AoA team scaled the annual operating cost up slightly, assuming significant economy of scale for facility operations (a 0.25 exponential scaling factor was used since basic staffing levels are not expected to be directly related to facility capacity/size but represent basic operations and associated support staff). The resultant annual operations cost is $56M in FY 2018 dollars. To that, the AoA team added the cost for grout raw material, also based on Saltstone analysis, of $0.67 per gallon of waste processed, resulting in an additional $12M per year for the OSGF needed for Alternative 18. While the actual waste volume will vary from year to year, this amount, based on maximum volume, was retained for all years of operation of the OSGF. The resultant annual operating cost for the OSGF then is $68M per year (FY 2018 dollars).

The AoA team assumed there would be no additional costs incurred to dispose of the grout in the on-site IDF, as those costs would not be appreciably different than are incurred during normal IDF operation. However, the AoA team determined that the capacity of the existing IDF will be exceeded due to the higher waste volume generated by the OSGF. In that case, either a new IDF will need to be constructed, or an off-site disposal path will need to be established. Neither the capital costs to construct a new IDF at Hanford or the disposal costs associated with additional off-site disposal of the LAW grout have been included in the LCCE for Alternative 18 due to a lack of definition and basis for such costs.

5.2 Cost Estimates – Unconstrained Funding

The LCCE results for Alternative 18 are summarized in Table 15, which also provides the results for the previously evaluated alternatives for comparison purposes.

Table 15: LCC Summary - Unconstrained Funding

#	Alternative Name	TPC ($B)*	LCC ($B)	PV ($B)
1	HLW Pretreatment in PT Facility (Baseline Case)	38.0	341	151
2	HLW Pretreatment in HFPF	41.0	215	125
5	Repurpose PT Facility for HLW Pretreatment and HLW Effluent Management	39.3	217	123
14	New HFPF (with Filtration) and New HEMF	33.9	212	119
15	DFHLW and HLW Effluent Processing in New HEMF	35.2	214	121
16	HLW Pretreatment in DSTs and in Feed Preparation Tanks in New HEMF	35.6	213	121
17	DFHLW Single Melter HLW Without Evaporators or LAWST Facility	9.0	5,099	423
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	20.0	199	97

PV – present value

* *Includes TPC for only Alternative-specific projects and does not include those ancillary/supporting projects common to all alternatives (e.g., LBL/DFLAW Completion, HSF/IHS, and needed tank farm projects.*

A summary breakdown of the Alternative 18 costs can be found in Table 34 (in Section 8.3 of this Addendum), which also compares those costs to the estimate for Alternative 14, the most similar of the previously considered alternatives in terms of process, albeit without the phase approach used for Alternative 18. The funding profile for the unconstrained case is shown in Figure 16.

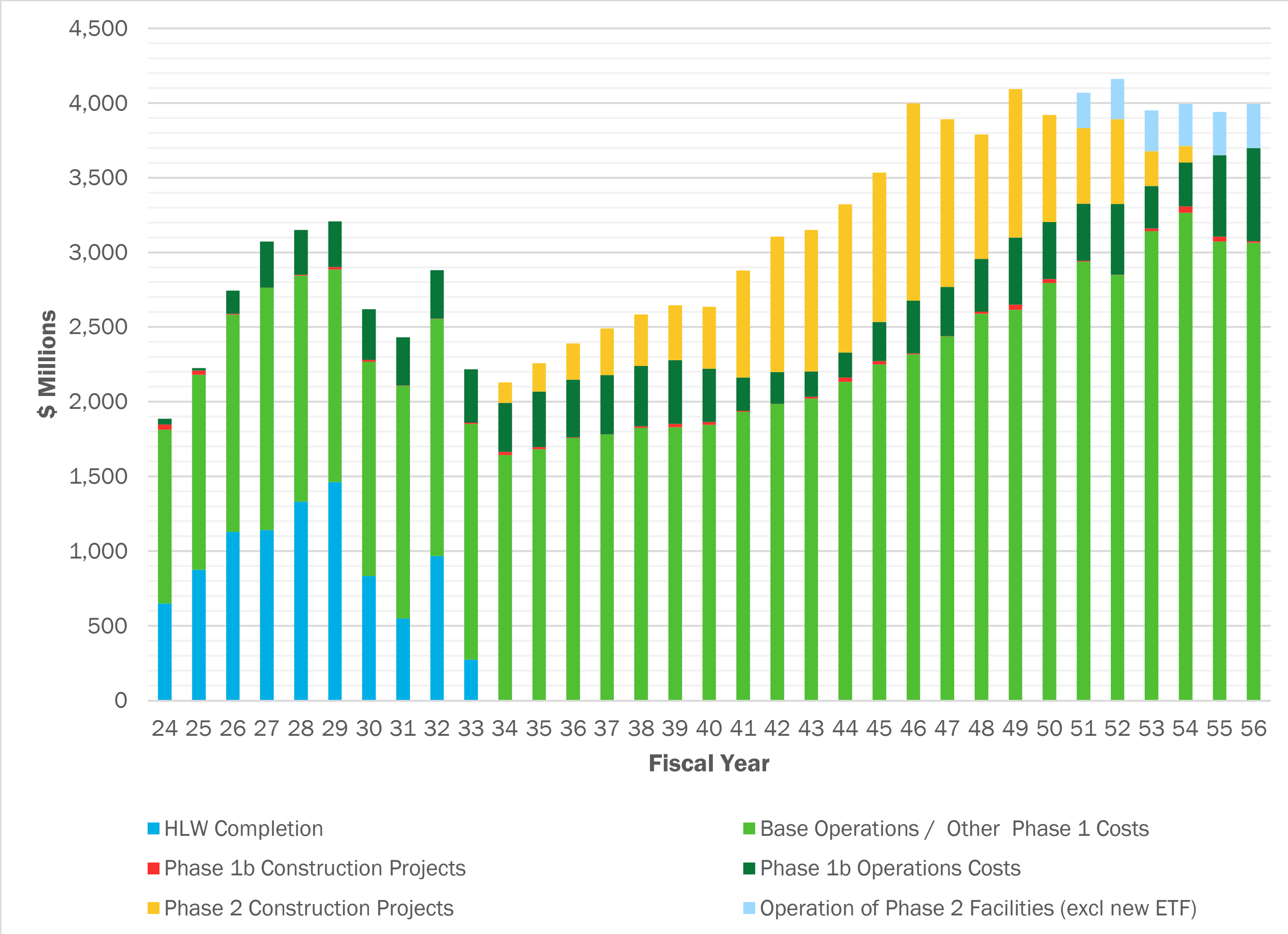


Figure 16: Unconstrained Funding Profile

5.3 Constrained Funding Analysis

The initial LCCE for Alternative 18 was developed assuming unconstrained funding is available. The resultant required funding is summarized in Table 35 in Section 8.3 of this Addendum by major elements proposed for the phased implementation approach envisioned for Alternative 18. The AoA team was directed to assume that available funding per year would be capped at no more than $2.5 billion beginning in FY 2024. As can be seen in Table 35, Alternative 18 as currently planned and modeled is not feasible within that funding constraint, with available funding being consumed as soon as FY 2028. This is because funding is needed for the base operations of the tank farm, the Phase 1 operations needed for DFLAW, initiation of the planned Phase 1B activities (including treatment and disposal of LAW at off-site facilities), and completion of the HLW Vitrification Facility. Accordingly, it would not be possible to meet the ACD milestone for start of operations of the HLW Vitrification Facility by December 2033.

To focus on achieving that ACD milestone under the constrained funding limit, the AoA team evaluated the impact of deferral or delay of Phase 1b, as currently modeled and described for Alternative 18. A delay of eight years to the start of Phase 1B operations from FY 2026 to FY 2034 was assumed for the constrained funding scenario analysis. The analysis assumes that unused funding in any year can be accumulated as carryover funding that can be used in subsequent years. The results of this effort shows that the ACD milestone can be met within the proposed constrained funding limit, as can be seen in Figure 17 below and Table 36 (see Section 8.3 of this Addendum). Although there is one year in which cumulative available funding is not available (FY 2029), the amount is relatively small, and it is expected the actual schedule for completion of the HLW Vitrification Facility could be adjusted to eliminate this issue.

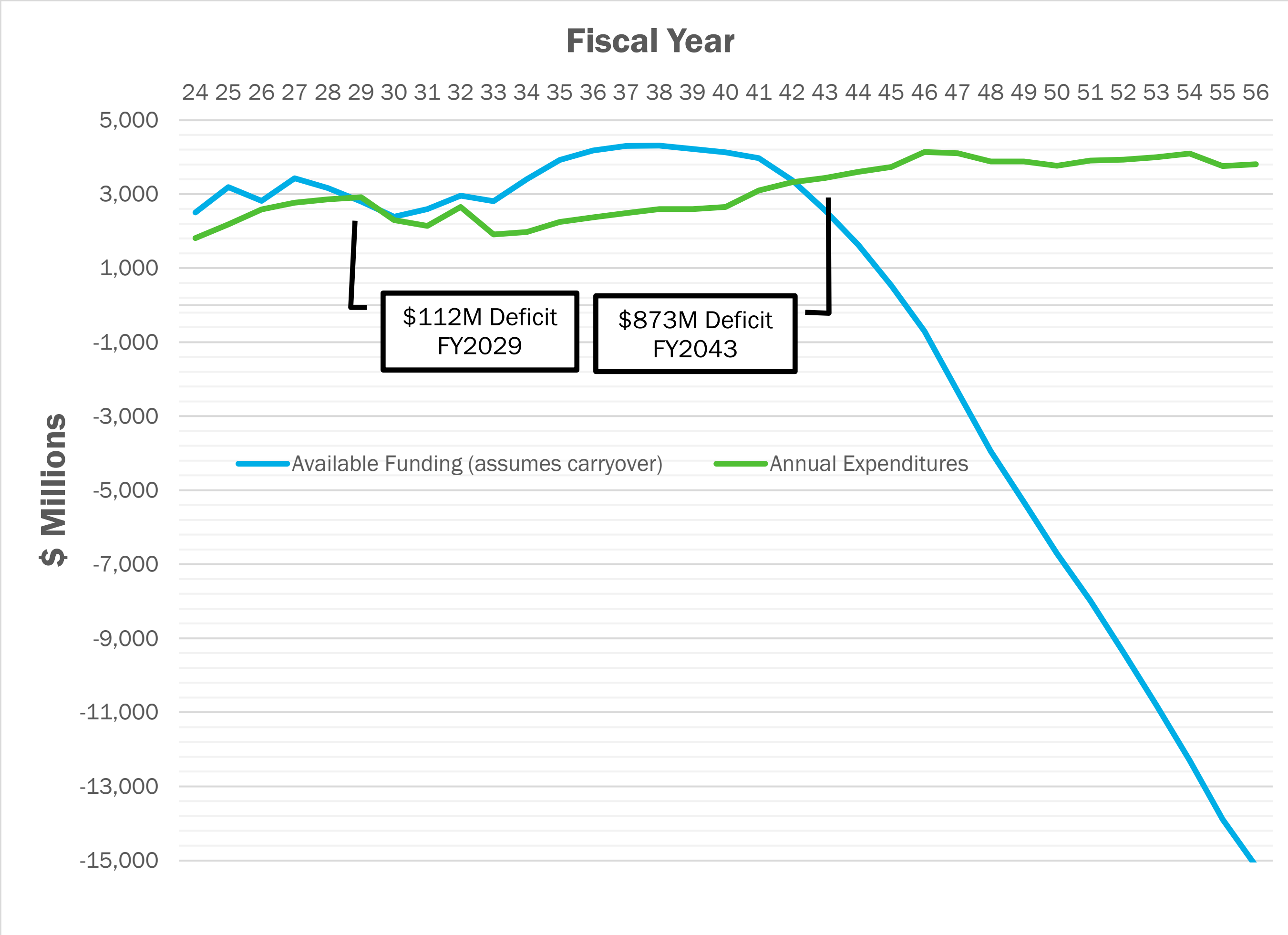


Figure 17: Constrained Available Funding vs. Expenditures

The Phase 1B activities that are deferred or delayed under the constrained funding scenario are as follows:

- Construction Capital Cost of SW TSCR – start delayed from FY 2023 to FY 2031
- Construction Capital Cost of Load Out Station - start delayed from FY 2023 to FY 2031
- Operation of SW TSCR – start delayed from FY 2026 to FY 2034
- Treatment and Disposal of LAW from West Area – start delayed from FY 2026 to FY 2034
- Phase 1B Tank Farm operational activities delayed eight years:
  - SW SST Retrievals in S, SY, and U Tank Farms
  - Interim Closure of S, ST, and U Tank Farms
  - Activities associated with SW Quadrant DSTs (SY-101. SY-102, and SY-103)

Even with this approach, which enables the ACD milestone for completion of hot commissioning of the HLW Vitrification Facility to be met, as can be seen in Figure 17 above and Table 36, there is inadequate funding available to continue the Phase 1 and 1B waste processing mission as planned for Alternative 18 beyond FY 2043. Funding is also not available for completion of the new LAW and HLW processing facilities needed for Phase 2. As a result, Phase 2 operations cannot be started under this constrained funding scenario.

The AoA team also considered an alternative scenario in which the Phase 1B operations are started as planned in FY 2026 and the completion of the HLW Vitrification Facility is delayed beyond the ACD milestone based on the more limited funding that would be available. This approach results in a delay of the start of HLW operations until approximately FY 2040, at which time there will be no remaining funding available to continue with the construction of the Phase 2 facilities or to continue any waste processing operations.

The AoA team evaluated what the constrained funding level may need to be to actually complete the mission as planned by Alternative 18. Flat funding of $3.7 billion per year beginning in FY 2024 may be adequate to complete the mission, with appropriate reductions in the outyears as the needed funding begins to decrease. Alternatively, it may be possible to complete the mission by stepping up the annual funding limits over time. For example, increasing the cap from $2.5 to $3 billion in FY 2034, to $4 billion in 2045, and to $4.8 billion in 2065 may enable the mission to be completed as planned.

The AoA team evaluated a cost sensitivity to determine the minimum annual funding increase to mitigate funding shortfalls of the $2.5B annual constraint. In addition to Alternative 18, the sensitivity was also applied to Alternatives 1 and 5 from the original AoA since they could not construct all necessary facilities for operations.

The AoA team determined that an annual increase in funding of 1.5% per year, beginning in FY2025 would have the following results:

- Alternative 1: The HLW/PT Facility can be completed in FY2046
- Alternative 5: The HLW/PT Facility can be completed in FY2039
- Alternative 18: Funding shortfall is mitigated

In order to complete HLW/PT by FY2034, as required, the annual funding increases for Alternatives 1 and 5 are 6% and 4.5%, respectively.

The conclusion of this analysis is that the full tank waste processing mission, as planned for Alternative 18, cannot be completed under the proposed $2.5 B funding constraint. This is the same conclusion reached for the other alternatives considered as part of this AoA. However, Alternative 18 does offer the potential to delay the necessary significant increase in annual funding availability until some 20 years in the future, with a corresponding LCCE impact that cannot be fully quantified pending guidance on what future funding can be made available. It is also important to note that the above-described analysis is based on the point estimates developed for Alternative 18. At the high end of the cost estimate range for both capital (+100%) and operating costs (+50%), the funding constraint has a much greater impact, and it is likely that even the ACD milestone for start of HLW operations will not be met.

5.4 Cost Ranges

The same cost ranges as used for the other evaluated alternatives are applicable for the Alternative 18 LCCEs. The ranges are from -50% to +100% for all capital project costs, and from -30% to +50% for all operating costs. The results of applying these ranges to the Alternative 18 estimates, and the comparison of those results to the previously evaluated alternative, are shown in Table 16 and Table 17.

Table 16: PV LCC Ranges - Unconstrained Funding

#	Alternative Name	Low ($B)	Point ($B)	High ($B)
1	HLW Pretreatment in PT Facility (Baseline Case)	98	151	246
2	HLW Pretreatment in HFPF	80	125	208
5	Repurpose PT Facility for HLW Pretreatment and HLW Effluent Management	78	123	205
14	New HFPF (with Filtration) and New HEMF	76	119	196
15	DFHLW and HLW Effluent Processing in New HEMF	77	121	200
16	HLW Pretreatment in DSTs and in Feed Preparation Tanks in New HEMF	77	121	200
17	DFHLW Single Melter HLW Without Evaporators or LAWST	242	423	770
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	63	97	157

Table 17: LCC Ranges - Unconstrained Funding

#	Alternative Name	Low ($B)	Point ($B)	High ($B)
1	HLW Pretreatment in PT Facility (Baseline Case)	228	341	539

#	Alternative Name	Low ($B)	Point ($B)	High ($B)
2	HLW Pretreatment in HFPF	139	215	350
5	Repurpose PT Facility for HLW Pretreatment and HLW Effluent Management	142	217	352
14	New HFPF (with Filtration) and New HEMF	139	212	341
15	DFHLW and HLW Effluent Processing in New HEMF	140	214	346
16	HLW Pretreatment in DSTs and in Feed Preparation Tanks in New HEMF	139	213	344
17	DFHLW Single Melter HLW Without Evaporators or LAWST	2,835	5,099	9,484
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	132	199	318

5.5 Schedule Analysis

A P6 schedule was developed by the WRPS modeling software and data from the model was input into Primavera in an automated fashion. The schedule has 5,613 activities, with a start date of Oct 3, 2016 and a completion date of June 28, 2080, for an overall project duration of 63 years and 8.75 months.

Key schedule milestones can be seen in the summary schedule in Figure 18.

Activity Name	Original Duration	Start	Finish
AoA_Alternative 18	16056d	03-Oct-16	01-Jul-80
River Protection Project	16056d	03-Oct-16	01-Jul-80
TSCR Start Date	0d	24-Mar-23*	
Start WTP LAW Processing (A-9) [31-Dec-2023]	0d	31-Dec-23*	
Complete Nine Aadditional SST Retrievals (B-2) [31-Mar-2024]	0d		30-Nov-26
Close Waste Management Area C (M-045-83) [30-Jun-2019]	0d		30-Jun-28
Start WTP HLW Processing (A-4) [31-Dec-2033]	0d	31-Dec-33*	
Start HLW Prep Facility (HFPEM)	0d	31-Dec-50*	
Complete all SST Retrievals (M-045-70) [31-Dec-40]	0d		20-Aug-70
Close all SSTs (M-045-00) [31-Jan-2043]	0d		03-Sep-74
Retrieve all double-shell tanks (DST)	0d		30-Aug-75
Treat all tank waste (M-062) [31-Dec-47]	0d		24-Oct-75
Close all DSTs (M-42) [30-Sep-52]	0d		28-Jun-80
RPP Project Completion	0d		28-Jun-80
Base Operations	15554d	01-Oct-18	28-Jun-80
Retrieve and Close SSTs	15554d	01-Oct-18	28-Jun-80
WFD/Treatment Plng/DST Retrieval/Closure	16056d	03-Oct-16	28-Jun-80
Supplemental Treatment	13719d	03-Oct-23	22-Mar-78
Treat Waste	15554d	01-Oct-18	01-Jul-80
Facility Closures	13425d	11-May-26	24-Aug-79
Tank Operations Contract - ORP Project Support	16166d	03-Oct-16	28-Jun-80

Figure 18: Alternative 18 Schedule

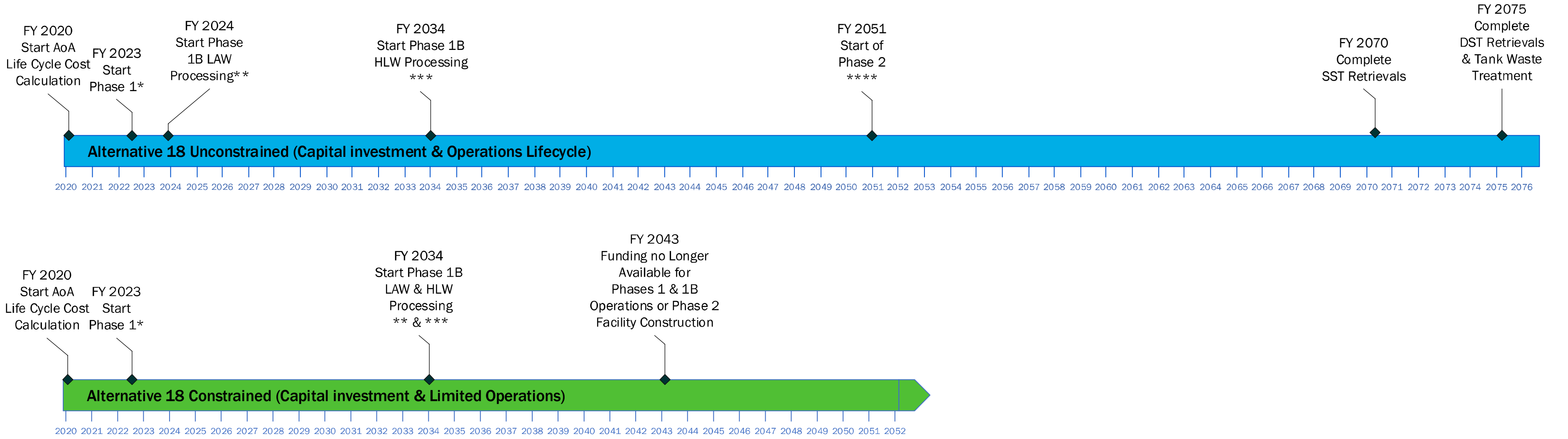
The WRPS P6 schedule for Alternative 18 is based on the logic contained within TOPSim for sequencing tank retrievals, waste transfers, and LAW and HLW pretreatment and treatment. TOPSim also includes constraints for processing rates and facility availability based on the design of the existing waste transfer system and waste processing facilities, and the preconceptual processing rates assumed for new facilities.

Although TOPSim contains highly detailed and technically sound sequencing logic and technical planning constraints, that logic is not fully reflected in the P6 schedule. Additionally, some of the facility modifications and new construction work that is assumed in TOPSim is defined at the preconceptual level. As a result, the detailed work execution activities for this scope are not currently included in the P6 schedule. The WRPS P6 schedule does however identify the major work activities and milestones which is adequate for alternative analysis purposes as described in the DOE Cost Estimating Guide[58].

The WRPS P6 schedule is resource loaded and assumes sufficient resources and materials will be available to complete all work as planned. The work execution order is derived from the model and many activities, such as those for the 30+ SST infrastructure upgrades, are executed concurrently. Other work, including that for tank retrievals, also assumes resource and material availability will be unlimited. It should be noted that other ongoing, large capital projects in the DOE complex (UPF, CMRR, and ER) have found it challenging to meet resource and material needs. Finally, the model assumes no cost or budget constraints when scheduling work, which may prove to be unrealistic when compared to current spend plans at the site.

Notional milestone schedules for the unconstrained and constrained cases can be seen in Figure 23. The unconstrained schedule is based on milestone dates from the WRPS model, while schedule dates for the constrained case were derived via the funding analysis as discussed in Section 5.3 of this Addendum. In the constrained case, a funding cap of $2.5B annually allows for the construction of Phase 1 and 1B facilities but not their continued operations past FY2034 or the construction of Phase 2 facilities. The unconstrained case assumes full material and resource availability during both the construction and lifecycle phases.

[58] DOE G 413.3-21A, Cost Estimating Guide, June 6, 2018



* Required Phase 1 Facilities: LAW Vit Facility, WTP EMF, AP TSCR & IDF

** Required Phase 1B LAW Facilities: SY TSCR, SY LILO Station, PFNW Facility, WCS Facility

*** Required Phase 1B HLW Facilities: HLW Vit Facility, WTV, IHS, AP TFPT

**** Required Phase 2 Facilities: East & West Area WRF, Higher Capacity AP TFPT, AP LILO Station, LFE, OSGF, New Higher Capacity ETF, HFPEM Facility

Phase 2 is not achievable in the constrained case.

Figure 19: Alternative 18 Milestone Schedule

6 Alternative 18 Evaluation

6.1 Qualitative Risk Assessment

The AoA team used the qualitative risk assessment register (see Appendix F in the AoA Report) as a template to evaluate threats and opportunities for Alternative 18. Table 18 shows the composite risk ratings (including corresponding risk scores in parentheses that accounts for both threats and opportunities) for each alternative under unconstrained and constrained funding assumptions. The risk ratings and scores represent “pre-mitigation” values.

Table 18: Composite Risk Ratings

		Project / Technical Risk Rating		Operations Risk Rating		Programmatic Risk Rating	
#	Alternative Name	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained
1	HLW Pretreatment in PT Facility (Baseline Case)	Moderate (2.82)	Not Applicable	Moderate (2.88)	Not Applicable	Moderate (2.92)	Not Applicable
2	HLW Pretreatment in HLW Feed Preparation Facility (HFPF)	Low (2.47)	Moderate (2.85)	Moderate (2.69)	Moderate (3.13)	Moderate (3.15)	High (3.46)
5	Repurpose PT Facility for HLW Pretreatment and HEMF	Moderate (2.94)	Not Applicable	Moderate (2.81)	Not Applicable	Moderate (3.08)	Not Applicable
14	New HFPF (with Filtration) and New HEMF	Low (2.47)	Moderate (2.65)	Moderate (2.81)	Moderate (3.25)	Moderate (3.15)	High (3.46)
15	DFHLW and HLW Effluent Processing in New HEMF	Moderate (2.65)	Moderate (2.82)	Moderate (3.06)	High (3.50)	Moderate (3.23)	High (3.54)
16	HLW Pretreatment in Double-Shell Tanks (DSTs) and in Feed Preparation Tanks in New HEMF	Moderate (2.65)	Moderate (2.82)	Moderate (3.06)	High (3.50)	Moderate (3.23)	High (3.54)
17	DFHLW Single Melter HLW Without Evaporators or LAWST	Low (2.29)	Low (2.35)	Moderate (3.06)	Moderate (3.13)	Moderate (3.15)	Moderate (3.15)
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	Moderate (2.82)	Not Applicable	Moderate (2.88)	Not Applicable	Moderate (3.31)	Not Applicable

The following sections summarize the risk assessment results for the unconstrained funding and constrained funding scenarios. For AoA Alternatives (1, 2, 5, 14, 15, 16, 17), Appendix F of the AoA Report contains detailed tables for project/technical, operations, and programmatic threats and opportunities, including the rationale for probability and consequence selections and mitigation strategies and post mitigation evaluations for threats originally rated as moderate, high, or very high. Details on Alternative 18 are found in Section 8.1 of this Addendum.

6.1.1 UNCONSTRAINED FUNDING RISK ASSESSMENT

Table 19 summarizes risk ratings for project/technical, operations, and programmatic threats and opportunities for each alternative based on unconstrained funding.

Table 19: Composite Risk Ratings - Unconstrained Funding

#	Alternative Name	Project/Technical Risk Rating	Operations Risk Rating	Programmatic Risk Rating
1	HLW Characterization and Staging in New Tank Waste Characterization and Staging Facility (TWCSF) and HLW (and LAW) Pretreatment in PT Facility (Baseline Scenario)	Moderate	Moderate	Moderate
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	Low	Moderate	Moderate
5	HLW Pretreatment and Effluent Management in Repurposed PT Facility	Moderate	Moderate	Moderate
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	Low	Moderate	Moderate
15	DFHLW from DSTs and Effluent Management in New HEMF	Moderate	Moderate	Moderate
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	Moderate	Moderate	Moderate
17	DFHLW from DSTs without HLW Effluent Management	Low	Moderate	Moderate
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	Moderate	Moderate	Moderate

The following summarizes the top threats (five rated Very High and three rated High) associated with Alternative 18 based on unconstrained funding.

- Project/Technical Threat #2. Changes in mission requirements (e.g., RPP Mission Analysis, Program Requirements Document) and/or project execution requirements (e.g., project functions and requirements, Project Execution Plan) result in the need to reevaluate the HLW treatment mission, project execution approach, and/or the technical, cost, and schedule baselines for the HLW pretreatment and treatment projects. This impacts the schedule and cost for completing treatment facility/system design, construction, startup, and commissioning. (Very High)
- Project/Technical Threat #12. Contractor performance in planning, managing, and executing design (including errors and omissions), construction, startup, and commissioning is below planned levels, resulting in schedule delays and increased project costs. (Very High)
- Programmatic Threat #1. Delays in the approval (or inability to obtain approval) of new permits or changes to existing permits for HLW treatment facilities negatively impact project costs and schedules and subsequent processing schedules and associated costs. (Very High)
- Programmatic Threat #6. Funding shortfalls delay completion of design, construction, startup, and commissioning of HLW pretreatment and vitrification facilities, resulting in extended HLW treatment mission duration and increased costs. (Very High)
- Programmatic Threat #7. The schedule for completing design, construction, startup, and commissioning of the required HLW pretreatment and treatment facilities deviates from the current ACD and associated existing regulatory framework, which increases the time and level of effort required to negotiate ACD changes. (Very High)
- Operations Threat #1. The 242-A Evaporator facility availability is less than assumed due to equipment reliability issues or abnormal operational events or accidents, resulting in delays to the planned tank retrieval schedules and/or WFD schedules. (High)
- Operations Threat #7. A leak or other failure in a DST (excluding AP 105, 106, 107 and 108) causes alteration in WFD schedules and the need for DST space to accommodate waste from the leaking/failed tank, resulting in delays in the overall HLW (and LAW) treatment schedule and an increase in LCCs. (High)
- Programmatic Threat #12. High activity solid waste is generated that cannot be treated or disposed of (no currently defined treatment capability or disposition path), which results in increased LCCs. (High)

The Alternative 18 unconstrained funding risk level results (along with the other alternatives previously evaluated) for project/technical, operations, and programmatic threats and opportunities, respectively, are summarized in Table 20, Table 21, and Table 22, below.

6.1.2 ALTERNATIVE 18 SUMMARY AND OTHER RISK CONSIDERATIONS

Alternative 18 includes the phased startup for treating the Hanford tank waste based on grouping SSTs and DSTs into SE, SW, NE, and NW Quadrants and includes three phases. Phase 1 is based on the flowsheet from Alternative 17 and focuses on the treatment of LAW from retrieval of the SE-Quadrant SSTs (i.e., A, AX, and C Tank Farms). Phase 1B begins in 2025 andinitially prioritizes the treatment and disposal of LAW retrieved from the SW Quadrant SSTs (i.e., S, SX, and C Tank Farms) using off-site commercial facilities. In the latter part of Phase 1B, HLW pretreatment and treatment starts using the DFHLW approach of Alternatives 15 through 17. Phase 2, which begins in 2050, focuses on the treatment of LAW and HLW retrieved from the NE Quadrant (i.e., B, BX, and BY Tank Farms) and NW Quadrant (i.e., T, TX, and TY Tank Farms) SSTs using higher capacity pretreatment and treatment facilities. Specific details of each phase are summarized as follows:

- First, in Phase 1, the DFLAW process uses a TSCR process to pretreat LAW retrieved from the SE Quadrant, which includes SSTs in the A, AX, and C Tank Farms along with all DSTs except those in the SY Tank Farm. The pretreated LAW is sent directly to the WTP LAW Vitrification Facility beginning in 2023.
- Second, in Phase 1B, treatment and disposal of the LAW in the SW Quadrant SSTs and DSTs starts in 2025 while Phase 1 facilities continue to operate. The Phase 1B LAW processing approach includes a TSCR process to pretreat LAW in the SW Quadrant and commercial off-site facilities to treat (grout) and dispose of the LAW. Later in Phase 1B (FY 2034), HLW processing is started using pretreatment in the DSTs and treatment (vitrification) in the HLW Vitrification Facility.
- Last, in Phase 2 (startup in 2050), new higher capacity LAW and HLW processing facilities are started including WRFs to collect and route waste retrieved from the B and T complex SSTs, an LFE to concentrate the LAW feed, an OSGF to treat (grout) the supplemental LAW stream, an HFPEM Facility to pretreat HLW and to process HLW liquid effluents, and the HLW Vitrification Facility to treat (vitrify) the HLW. A new higher capacity ETF is also required to process the higher volumes of process condensate generated in Phase 2. The HFPEM Facility uses the same cross-flow filtration capabilities used in Alternative 14. Retrieval of the B and T complex SSTs begins as soon as the SW Quadrant SSTs have been retrieved and adequate space is available in the DST system. Phase 1 and 1B facilities continue to operate, with the exception of off-site grout treatment.

In addition to the Alternative 18 risk results used for comparison purposes to other alternatives, there are also Alternative 18 risks that warrant highlighting and consideration. These risks include, but are not limited to:

- RCRA organics and PCBs are present in some tank wastes, which poses an issue for grouting. The concentration of some organics may exceed the LDR, and grout is not an approved treatment. Lack of precision in existing inventory data creates challenges. However, organics are unlikely to pose an issue for grout curing/stability.
- Tc-99, I-129 and nitrate may pose an issue for on-site disposal of grouted waste. The IDF performance assessment would have to be revised to demonstrate that Tc-99, I-129, and heavy metals would not leach out.
- Treatment of the supplemental LAW stream using a grout process results in higher volumes of immobilized waste to be disposed of in the IDF. The projected volume of space required for disposal of the grout containers from the OSGF and the ILAW from the LAW Vitrification Facility exceed the capacity of the IDF specified in the Performance Assessment.
- Construction of a new OSGF requires a new DWP, and obtaining approval for a new DWP could be problematic. The programmatic permitting risk has been evaluated to be high.
- Interstate transportation of solid LLW may pose a risk. The waste classification for the grout generated by the PFNW facility is assumed to be Class C LLW, which has higher radionuclide concentrations than Class A or B. The assumption is that the grout containers will be shipped by rail to WCS. While WCS routinely receives shipments of solid LLW from waste generators in many different states, interstate shipment of solid LLW resulting from treatment of Hanford tank waste could lead to legal challenges by one or more states on the proposed transportation route.

Table 20: Qualitative Risk Assessment Summary – Project/Technical Threats and Opportunities – Unconstrained Funding

Alt #	Tech and science maturity T1	Changes in reqmt's T2	Changes code of record T3	Changes in safety basis T4	System interface complex T5	Safety incident delays T6	DNFSB issue delays T7	PT re-purpose delays T8	Site specific cond T9	Control of p/C changes T10	Equip. aging & obsol T11	Contr perf issues T12	Suffic qualif person T13	TF upgrade delays T14	ETF upgrade delays T15	Use of existing equip Op1	Excess BOF[1] Capacity OP2
1	Moderate	Moderate	Moderate	Very Low	Low	Very Low	Low	Very Low	Moderate	Moderate	Moderate	Very High	High	Low	Low	Very Low	Very Low
2	Very Low	Moderate	Low	Very Low	Moderate	Very Low	Very Low	Very Low	Moderate	Moderate	Low	Very High	High	Low	Moderate	Low	Moderate
5	Low	High	Moderate	Very Low	Moderate	Very Low	Low	High	Very Low	Moderate	Moderate	Very High	High	Low	Low	Very Low	Very Low
14	Very Low	Moderate	Low	Very Low	Moderate	Very Low	Very Low	Very Low	Moderate	Moderate	Low	Very High	High	Low	Moderate	Low	Moderate
15	Very Low	Moderate	Low	Moderate	Moderate	Very Low	Very Low	Very Low	Moderate	Low	Low	Very High	High	Moderate	Moderate	Very Low	Moderate
16	Very Low	Moderate	Low	Moderate	Moderate	Very Low	Very Low	Very Low	Moderate	Low	Low	Very High	High	Moderate	Moderate	Very Low	Moderate
17	Very Low	Very High	Low	Moderate	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Low	High	Low	Low	Low	Very Low	Very Low
18	Low	Very High	Low	Moderate	Moderate	Very Low	Very Low	Very Low	Moderate	Moderate	Low	Very High	Moderate	Moderate	Moderate	Very Low	Moderate

[1]BOF – Balance of Facilities

Table 21: Qualitative Risk Assessment Summary – Operations Threats and Opportunities – Unconstrained Funding

Alt #	242-A avail & reliab. T1	Cross site transfer start up T2	Cross site transfer avail T3	TF waste feed del infrastr T4	222-s LAB avail T5	WTP lab function T6	DST leak/ failure T7	DST repurp degrad T8	Sustain through rates T9	DST leak/ failure (ap 105-AP 108) T10	BOF Facilities capabil T11	Mission design life T12	Site infrastr avail T13	Labor to support LAW/HLW T14	Waste load improv Op1	Higher oper effic. Op2
1	Very High	Moderate	Low	Low	Low	Very Low	Moderate	Moderate	High	Moderate	Low	High	Moderate	Low	Low	Moderate
2	Moderate	Moderate	Moderate	Low	Moderate	Very Low	Moderate	Moderate	Moderate	Moderate	Very Low	Moderate	Moderate	Low	Low	Moderate
5	Moderate	Moderate	Moderate	Moderate	Low	Very Low	High	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate
14	Moderate	Moderate	Moderate	Moderate	Moderate	Very Low	High	Moderate	Moderate	Moderate	Very Low	Moderate	Moderate	Low	Low	Moderate
15	High	Moderate	Moderate	Moderate	Moderate	Very Low	Very High	Very High	Moderate	Moderate	Very Low	Moderate	Moderate	Low	Low	Moderate
16	High	Moderate	Moderate	Moderate	Moderate	Very Low	Very High	Very High	Moderate	Moderate	Very Low	Moderate	Moderate	Low	Low	Moderate
17	Very High	Very Low	Very Low	Moderate	Low	Very Low	Very High	Very High	Very Low	High	Very Low	Very High	High	Very Low	Very Low	Very Low
18	High	Moderate	Moderate	Moderate	Moderate	Very Low	High	Moderate	Moderate	Moderate	Very Low	Moderate	Moderate	Low	Low	Moderate

Table 22: Qualitative Risk Assessment Summary – Programmatic Threats and Opportunities – Unconstrained Funding

Alt #	Permitting approval delays T1	DFLAW delay impacts T2	Safety event during const T3	Safety event during ops T4	Supply chain mgt challenge T5	Funding shortfall delays T6	Deviation from ACD & Reg fram T7	Natl geo repos delay T8	Changes in IHLW WAC & packaging T9	New DOE dir/policy or ext regs T10	New external stake T11	Solid waste with no treat/disp T12	Change in waste class Op1
1	Moderate	Moderate	Low	Moderate	Moderate	Very High	Moderate	Moderate	Low	Low	Low	High	Moderate
2	High	Moderate	Low	Moderate	Moderate	Very High	High	Moderate	Low	Low	Moderate	High	Moderate
5	Moderate	Moderate	Low	Moderate	Moderate	Very High	High	Moderate	Low	Low	Moderate	High	Moderate
14	High	Moderate	Low	Moderate	Moderate	Very High	High	Moderate	Low	Low	Moderate	High	Moderate
15	Very High	Moderate	Low	Moderate	Moderate	Very High	Very High	Moderate	Low	Low	Low	High	Moderate
16	Very High	Moderate	Low	Moderate	Moderate	Very High	Very High	Moderate	Low	Low	Low	High	Moderate
17	High	Moderate	Low	High	High	Moderate	Very High	Low	Moderate	Moderate	Low	High	High
18	Very High	Moderate	Low	Moderate	Moderate	Very High	Very High	Moderate	Low	Low	Moderate	High	Moderate

Lastly, Figure 20 summarizes the number of identified threats by associated levels (Very High, High, Medium, Low, or Very low) for each alternative based on the constrained funding case.

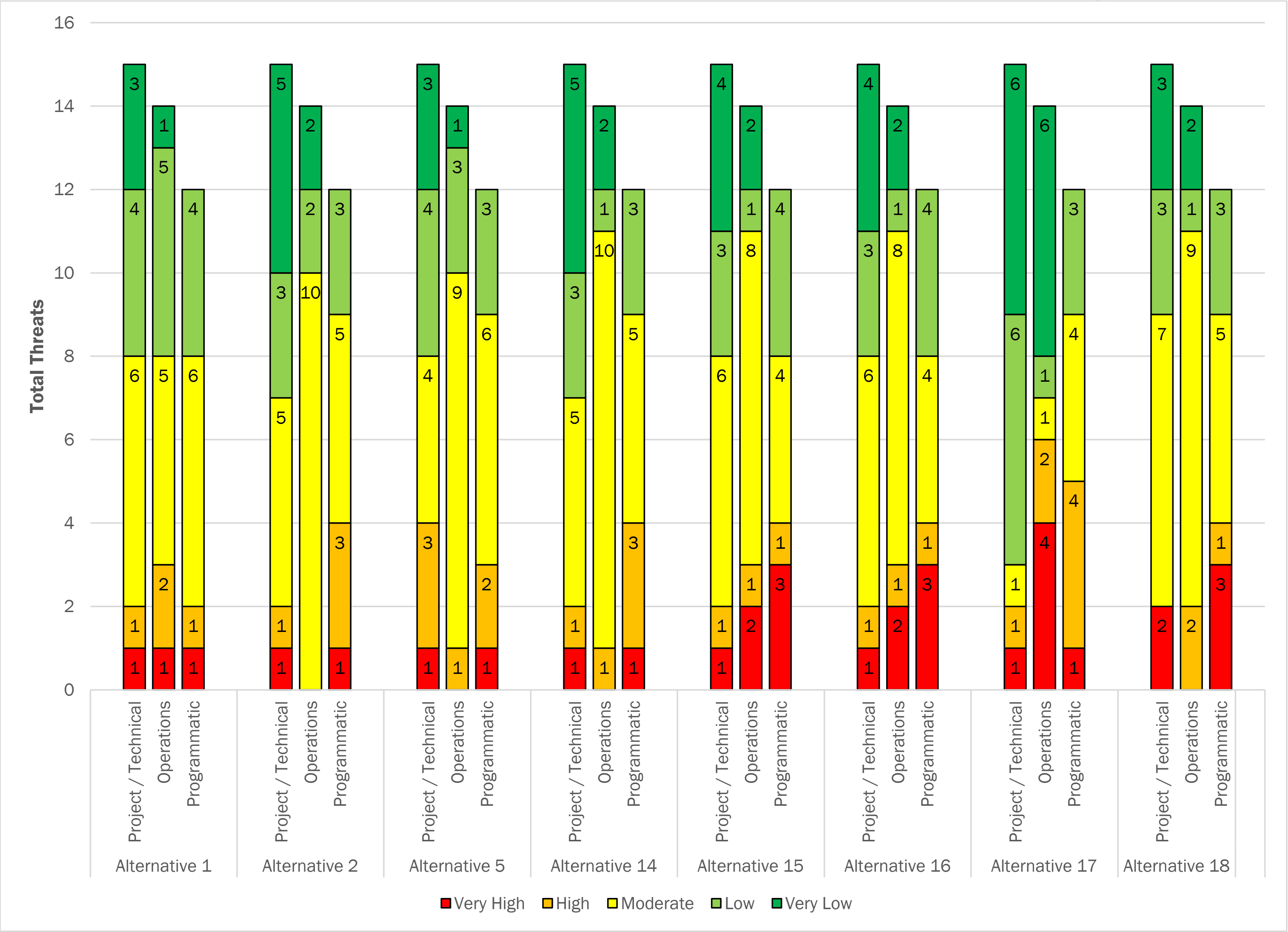


Figure 20: Alternative Threat Level Summary - Unconstrained Funding

6.1.3 CONSTRAINED FUNDING RISK ASSESSMENT

A qualitative risk assessment for Alternative 18 based on constrained funding was not conducted. This decision was based on the fact that the annual constrained funding of $2.5B, the capital investment required to design, construct, start up, and commission the facilities, and supporting infrastructure to establish Alternative 18 capabilities is insufficient. A similar decision was reached for Alternative 1 and Alternative 5.

6.2 Performance Against Evaluation Criteria

The AoA team evaluated Alternative 18 using the weighted analysis matrix described in Section 7.2 of the AoA Report and rated how completely each alternative met each evaluation criterion. The scoring system used is summarized in Table 23. Unlike the importance scoring, the criteria scoring is linear to prevent the difference in scores from being exaggerated.

Table 23: Evaluation Criteria Scoring Scale

Criteria Evaluation	Score
Fully meets the criterion	1.00
Generally meets the criterion	0.75
Somewhat meets the criterion	0.50
Barely meets the criterion	0.25
Does not meet the criterion	0.00

The scoring and associated rationale for individual scores for Alternative 18 are detailed in Section 8.2 of this Addendum.

To provide a consistent basis from which all alternative scores could be compared, the weighted scores were converted to a 0 to 100 grading scale (see description of calculating the normalized relative weighting in Section 7.1 in the AoA Report), with 0 being the lowest possible score and 100 being the highest possible score.

Individual criteria scores for each alternative are determined by multiplying the normalized relative weight for the evaluation criterion by the scores for each alternative. The scores for all evaluation criteria for each alternative are summed to determine a total weighted score. Table 24 summarizes the weighted scores for each alternative in the unconstrained funding case.

Table 24: Evaluation Results – Weighted Scores – Unconstrained Funding

#	Evaluation Criteria	NRW	Alt 1	Alt 2	Alt 5	Alt 14	Alt 15	Alt 16	Alt 17	Alt 18
EC-1	Alternative allows for earlier completion of HLW Vitrification Facility hot commissioning	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
EC-2	Lower HLW project TPC range	20.0	5.0	5.0	5.0	10.0	10.0	10.0	20.0	15.0
EC-3	Lower operational, technical, and programmatic risk	20.0	15.0	15.0	10.0	15.0	10.0	10.0	10.0	10.0
EC-4	Lower HLW processing LCC (PV range)	12.0	6.0	9.0	9.0	9.0	9.0	9.0	0.0	12.0
EC-5	Alternative allows for earlier completion of HLW treatment	8.0	4.0	8.0	8.0	8.0	8.0	8.0	0.0	6.0
EC-6	Increased flexibility within the tank farm system to recover from single point failures	8.0	4.0	8.0	8.0	8.0	6.0	6.0	0.0	6.0
EC-7	Fewer IHLW canisters produced	4.0	3.0	4.0	3.0	3.0	4.0	4.0	0.0	2.0
EC-8	Lower volume of ILAW generated by HLW processing	4.0	3.0	1.0	2.0	2.0	1.0	1.0	4.0	0.0
EC-9	Lower volume of secondary liquid effluent (process condensate) generated by HLW and LAW processing	4.0	2.0	0.0	1.0	1.0	0.0	1.0	4.0	2.0
	Totals	100	62.0	70.0	66.0	76.0	68.0	69.0	58.0	73.0

Under the $2.5 billion annual constrained funding, design, construction, start up, and commissioning cannot be completed for all the facilities needed for HLW processing for Phase 2 of Alternative 18. For that reason, the evaluation criteria cannot be completed under the constrained funding scenario, consistent with how Alternatives 1 and 5 were handled in the initial AoA.

6.3 Sensitivity Analysis

Sensitivity analyses are performed to test and document the sensitivity effectiveness estimates for each alternative. To perform the sensitivity analyses, the relative importance of the evaluation criteria are modified to determine which of the criteria are driving the performance (composite evaluation score) of the alternatives. In some cases, select evaluation criteria are eliminated to determine the performance of the alternatives independent of the selected criteria. Baseline evaluation criteria importance factors and resulting relative weightings are detailed in Section 7.2 of the AoA Report. The AoA team performed the same sensitivity scenarios, as described in Section 9.4 of the AoA Report.

6.3.1 SENSITIVITY RESULTS FOR THE UNCONSTRAINED FUNDING CASE

Table 25 summarizes the results of all sensitivity analyses for the unconstrained funding case.

Table 25: Sensitivity Results, Unconstrained Funding

	Baseline		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
ALT #	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK
1	62.0	7	61.1	7	58.3	7	71.1	5↑	52.5	7
2	70.0	3	66.7	2↑	75.0	2↑	78.9	2↑	62.5	3
5	66.0	6	66.7	2↑	72.9	6	73.7	3↑	57.5	6
14	76.0	1	72.2	1	79.2	1	81.6	1	70.0	1
15	68.0	5	63.9	5	72.9	5	71.1	6↓	60.0	5
16	69.0	4	66.7	2↑	74.0	4	72.4	4	61.3	4
17	58.0	8	50.0	8	39.6	7	55.3	8	47.5	8
18	73.0	2	63.9	5↓	75.0	3↓	69.7	7↓	66.3	2
	Baseline		**Scenario 5**		**Scenario 6**		**Scenario 7**		**Scenario 8**	
ALT #	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK	SCORE	RANK
1	62.0	7	63.0	7	50.0	7	60.9	7	60.0	4↑
2	70.0	3	67.4	4	61.7	3	70.7	3	65.0	3
5	66.0	6	63.0	7↓	53.3	6	66.3	6	70.0	1↑
14	76.0	1	73.9	1	70.0	2↓	77.2	1	70.0	1
15	68.0	5	67.4	4↑	61.7	3↑	68.5	5	55.0	6↓
16	69.0	4	68.5	3↑	61.7	3↑	69.6	4	60.0	4
17	58.0	8	63.0	6↑	50.0	7↑	58.7	8	40.0	8
18	73.0	2	72.8	2	71.7	1↑	77.2	1↑	50.0	7↓

Rank indicates the alternatives' order based on scoring, with a rank of 1 corresponding to the highest score.

Arrows indicate increase (↑) or decrease (↓) in rank relative to baseline rank.

In the Base Case and all but one of the eight sensitivity scenarios, Alternative 14 is the highest ranked. The exception is Scenario 6, where only cost, schedule, and risk are considered, for which Alternative 14 drops one rank to second place behind Alternative 18. Alternatives 14 and 18 tie for top ranking in Scenario 7, which eliminates Evaluation Criteria 7 and 8. These criteria are related to the volumes of HLW and ILAW generated.

Alternative 18 is the second highest ranked alternative in the Base Case and Scenarios 4 and 5, which eliminate Evaluation Criteria 1 and 6, respectively. Evaluation Criterion 1 is related to the completion date for hot commissioning of the HLW Vitrification Facility, which is assumed to be the same for all alternatives in the unconstrained funding case. Evaluation Criterion 6 relates to increased flexibility within the tank farm system to recover from single-point failures.

Alternative 18 is strongest in terms of TPC, LCC, and qualitative risk, and weakest in consideration of ILAW, HLW, and liquid effluent volumes. It is therefore not surprising to see it drop in rank, sometimes significantly, for the other sensitivity scenarios.

7 Summary Results

The AoA team analyzed Alternative 18 using the same methodology applied to all other AoA Alternatives. This included generating capital cost estimates, performing an LCC analysis, conducting a qualitative risk assessment, scoring against evaluation criteria, and a sensitivity analysis. As previously discussed, the addition of Alternative 18 necessitated a scoring reevaluation for the unconstrained funding case. The constrained funding cost analysis also concluded that Alternative 18 could not construct all the necessary facilities for the HLW mission, making Alternative 18 non-viable in the constrained funding case studied. Updated results of the WTP HLW AoA are summarized in Table 26.

After reevaluating scoring for the unconstrained funding case, Alternative 14 remained the highest scoring alternative (76.0), with Alternative 18 (73.0) second highest. The next grouping of alternatives are Alternatives 2 (70.0), 15 (69.0), 16 (68.0), and 5 (66.0). Alternative 1 scores four points lower (62.0), with Alternative 17 remaining the lowest score (58.0).

Table 26: AoA Results - Unconstrained Funding

#	Weighted Score	Start Date HLW Treatment Operations	Total Project Cost ($B)	Project / Technical Risk	Operational Risk	Programmatic Risk	Life Cycle Cost (PV, $B)	Complete HLW Treatment	Increased Operational Flexibility	# IHLW Canisters Produced	# ILAW Containers Produced	Volume of Secondary Liquid Effluent Produced
1	62.0	12/31/2033	38.0	Moderate	Moderate	Moderate	151	08/2084	Somewhat Meets	9,500	93,900	17 Mgal
2	70.0	12/31/2033	41.0	Low	Moderate	Moderate	125	07/2061	Fully Meets	8,200	101,400	34 Mgal
5	66.0	12/31/2033	39.3	Moderate	Moderate	Moderate	123	09/2064	Fully Meets	9,500	97,800	30 Mgal
14	76.0	12/31/2033	33.9	Low	Moderate	Moderate	119	09/2064	Fully Meets	9,500	97,800	30 Mgal
15	68.0	12/31/2033	35.2	Moderate	Moderate	Moderate	121	05/2064	Generally Meets	8,100	103,600	32 Mgal
16	69.0	12/31/2033	35.6	Moderate	Moderate	Moderate	121	10/2062	Generally Meets	8,100	102,000	31 Mgal
17	58.0	12/31/2033	9.0	Low	Moderate	Moderate	423	2168+	Doesn't Meet	14,900+	67,000+	8 Mgal
18	73.0	12/31/2033	20.0	Moderate	Moderate	Moderate	97	09/2075	Generally Meets	12,000	68,000*	22Mgal

* Alternative 18 produces 534,000 of grouted LAW in addition to 68,000 containers of vitrified ILAW

8 Supporting Details

8.1 Alternative 18 Risk Evaluation Details

8.1.1 ALTERNATIVE 18 PROJECT / TECHNICAL THREATS AND OPPORTUNITIES

		Pre-Mitigation Evaluation					Post-Mitigation Evaluation		
#	Risk Description	Likelihood	Consequence	Risk Level	Rationale	Mitigation Strategy	Likelihood	Consequence	Risk Level
T1	Lack of maturity of proposed HLW processing critical science and technologies results in delays to the start of HLW and LAW treatment due to (1) additional time required for technology development and testing, (2) additional time required to incorporate design and flowsheet margin to accommodate uncertainty in the efficacy of the technology, and (3) additional time required to make new technologies and science compatible with existing structures, systems, and components.	Low	Significant	Low	Likelihood: The likelihood of occurrence is low; significant amount of testing to date, no new technology. Consequence: The consequence of occurrence is significant; prep facility, ability to change design/size of facility, solids processing technology is key issue.				
T2	Changes in mission requirements (e.g., RPP Mission Analysis, Program Requirements Document) and/or project execution requirements (e.g., project functions and requirements, Project Execution Plan) result in the need to reevaluate the HLW treatment mission, project execution approach, and/or the technical, cost, and schedule baselines for the HLW pretreatment and treatment projects, impacting the schedule and cost for completing treatment facility/system design, construction, startup and commissioning.	Very High	Critical	Very High	Likelihood: The likelihood of occurrence is very high; revises the current execution approach. Consequence: The consequence of occurrence is critical; limited flexibility to accommodate changes during DFHLW phase, scope impacts could be substantial, results in changes in execution approach based on use of grout.	Accept.	Very High	Critical	Very High
T3	Unanticipated changes in the code of record for HLW processing projects result in design changes and increased project costs and schedule delays.	Moderate	Marginal	Low	Likelihood: The likelihood of occurrence is moderate; changes in the code of record are anticipated. Consequence: The consequence of occurrence is marginal; reliance on DST system; includes mixer pumps added to DSTs to mobilize waste for DFHLW phase; new structures have more ability to accommodate unanticipated changes and revise design.				
T4	Changes in the safety basis for HLW processing facilities result in design changes, increased project costs, and schedule delays.	Low	Critical	Moderate	Likelihood: The likelihood of occurrence is low; safety basis and design changes are known, likelihood of additional unanticipated changes is minimal. Consequence: The consequence of occurrence is critical; new processing activities planned for DSTs requires changes to the safety basis, DST system is old and radiologically-contaminated increasing the difficulty of safety basis changes for DFHLW phase; new facilities designed to Hazard Category 2.	Accept.	Low	Critical	Moderate
T5	System interfaces between HLW processing facilities and tank farms and WTP facilities are complex and not well-defined resulting in design, construction, startup and commissioning schedule delays and higher project and life-cycle costs.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; the interfaces for proposed new facilities are less defined and understood, more interfaces accounting for all three phases. Consequence: The consequence of occurrence is significant; interface between the WTV and HLW facility requires development of acceptance criteria for DFHLW; more complex, larger new facility.	Early identification, definition, and management of interfaces.	Low	Significant	Low
T6	Safety incidents associated with HLW pretreatment and treatment facility construction activities result in delays in project completion.	Low	Marginal	Very Low	Likelihood: The likelihood of occurrence is low; historical evidence is low probability of construction-related safety incidents. Consequence: The consequence of occurrence is marginal; experience with construction-related safety incidents indicates a safety stand downs with minor impacts to cost and schedule.				
T7	Delays in completing construction of the PT Facility, and/or the HLW Vitrification Facility, and/or completing facility modifications to address previously identified DNFSB technical and safety issues (e.g., including nuclear safety criticality technical issue [TI]) for high density solids), result in delays in facility hot operations and in the overall HLW treatment schedule, and increases in project and LCCs.	Very Low	Marginal	Very Low	Likelihood: The likelihood of occurrence is very low; applies only to HLW facility, previously identified DNFSB issues have been resolved but not closed. Consequence: The consequence of occurrence is marginal; lower impact, requires only addressing HLW facility.				
T8	The facility modifications that are required to segregate the LAW and HLW pretreatment functions within the PT Facility or "repurpose" its use (i.e., to serve a purpose that was not intended nor described in the facility technical baseline) are more complex than planned, resulting in additional facility design changes and delays in hot operations and the overall HLW (and LAW) treatment schedule.	Very Low	Negligible	Very Low	Likelihood: The likelihood of occurrence is very low; PT Facility not being used. Consequence: The consequence of occurrence is negligible; impact is inconsequential given that the PT Facility is not being used.				

#	Risk Description	Pre-Mitigation Evaluation Likelihood	Pre-Mitigation Evaluation Consequence	Pre-Mitigation Evaluation Risk Level	Rationale	Mitigation Strategy	Post-Mitigation Evaluation Likelihood	Post-Mitigation Evaluation Consequence	Post-Mitigation Evaluation Risk Level
T9	Site specific conditions (e.g., underground contamination, underground piping, soil conditions) result in extended schedules and increased costs.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; new construction expands footprint. Consequence: The consequence of occurrence is significant; slightly higher impact with delay in construction of new facilities.	Conduct sampling, modeling and rerouting as necessary.	Moderate	Significant	Moderate
T10	Control of program and contract management changes required to address completion of HLW pretreatment and treatment facilities is inadequate and delays project completion.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; addition of new facilities presents changes. Consequence: The consequence of occurrence is significant; larger, more complex new facility.	Improve configuration management and change control, conduct timely changes, and/or focus on interface and requirements management.	Moderate	Marginal	Low
T11	Existing equipment aging and obsolescence, inadequate facility layup maintenance, and incomplete as-built documentation resulting from the suspension of PT Facility and HLW Facility construction work, result in schedule delays and increased costs.	Moderate	Marginal	Low	Likelihood: The likelihood of occurrence is moderate; limited use of existing equipment. Consequence: The consequence of occurrence is marginal; no use of PT Facility; HLW vitrification equipment accounted for in estimate.				
T12	Contractor performance in planning, managing, and executing design (including errors and omissions), construction, startup, and commissioning is below planned levels resulting in schedule delays and increased project costs.	Very High	Critical	Very High	Likelihood: The likelihood of occurrence is very high; probability is very high based on experience, new facility to be constructed, and HLW facility to be completed. Consequence: The consequence of occurrence is critical; contractor performance to date has resulted in significant schedule delays and cost increases, completing HLW facilities is critical to meeting Consent Decree milestones.	Revise contract incentive structure, revise acquisition strategy, and/or break up larger projects into multiple smaller, more manageable projects.	High	Significant	Moderate
T13	There are not enough qualified design, construction, startup, and commissioning personnel available, resulting in delayed project schedules and increased project costs.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; includes construction of a new large, complex facility, and complete HLW facility however projects do not occur simultaneously. Consequence: The consequence of occurrence is significant; inadequate design, construction, startup, and commissioning personnel would have a significant impact on the project cost and schedule.	Increase hiring incentives, support (funding and services) local trade schools for trades that are in high demand, revise the sequencing of work from single shift to multiple shifts, increase remote support.	Moderate	Significant	Moderate
T14	Delays in tank farm upgrades, including installation of mixer pumps and waste transfer and tank farm infrastructure upgrades result in schedule delays and increased costs.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; tanks to be reconfigured, installation of new pumps, upgrades to pump pits, upgrade to ventilation systems. Consequence: The consequence of occurrence is significant; reliance on DSTs results in further delays to start up.	Conduct early planning and implementation of upgrades, change priority of infrastructure upgrades.	Low	Significant	Low
T15	Delays to upgrades for the Effluent Treatment Facility to treat all HLW secondary liquid effluents result in schedule delays and increased costs.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; the design treatment capacity for the existing ETF is adequate until Phase 2 starts, Alternative 18 assumes that a new higher capacity ETF will be constructed prior to starting Phase 2. Consequence: The consequence of occurrence is significant; if a higher capacity ETF is not available for Phase 2, the LAW and HLW processing rates will decrease which extends the tank waste treatment mission.	Conduct early planning and implementation of upgrades, revise priorities for upgrade projects.	Low	Significant	Low
O1	Use of already procured material and equipment reduces the capital investment required to construct the facilities needed for new HLW pretreatment or to modify and repurpose the PT Facility.	Low	Marginal	Very Low	Likelihood: The likelihood of occurrence is low; minor likelihood to use already procured material and equipment such as piping. Consequence: The consequence of occurrence is marginal; minimal reduction in capital investment based on limited use of already procured material and equipment.				
O2	The BOF facilities have excess design capacity to provide utility and process support capabilities to non-WTP facilities.	High	Marginal	Moderate	Likelihood: The likelihood of occurrence is high; higher likelihood of excess design capacity for alternatives with new facilities. Consequence: The consequence of occurrence is marginal; some utility and process support capability may be provided to non-WTP facilities.				

8.1.2 ALTERNATIVE 18 OPERATIONS THREATS AND OPPORTUNITIES

#	Risk Description	Pre-Mitigation Evaluation Likelihood	Pre-Mitigation Evaluation Consequence	Pre-Mitigation Evaluation Risk Level	Rationale	Mitigation Strategy	Post-Mitigation Evaluation Likelihood	Post-Mitigation Evaluation Consequence	Post-Mitigation Evaluation Risk Level
T1	The 242-A Evaporator facility availability is less than assumed due to equipment reliability issues or abnormal operational events or accidents, resulting in delays to the planned tank retrieval schedules and/or WFD schedules.	High	Critical	High	Likelihood: The likelihood of occurrence is high; number of annual evaporator campaigns is 3 - 6 up until 2050. Consequence: The consequence of occurrence is critical; no redundant evaporator capability until after 2050 at which point the dependency on 242-A is reduced.	Conduct more preventive maintenance, early replacement of key components, and/or rerouting to reduce significant additional load.	Moderate	Significant	Moderate

		Pre-Mitigation Evaluation					Post-Mitigation Evaluation		
#	Risk Description	Likelihood	Consequence	Risk Level	Rationale	Mitigation Strategy	Likelihood	Consequence	Risk Level
T2	Startup of the cross-site transfer system is delayed impacting waste transfer from 200 West Area to 200 East Area.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; startup typically delayed to need date based on funding; modeling assumes just-in-time delivery for startup and testing of lines, only slurry line is needed. Consequence: The consequence of occurrence is significant; no discernable difference in impact for all alternatives (except for Alternative 17).	Conduct proactive planning and early testing, resequence waste feed.	Moderate	Marginal	Low
T3	The cross-site transfer lines are unavailable or become unavailable (e.g., plugged) during transfers, impacting waste transfer from 200 West Area to 200 East Area.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; based on mission duration which is relatively consistent among alternatives (except for Alternative 17). Consequence: The consequence of occurrence is significant; mission driven by SST retrievals.	Develop and implement corrective measures (tools, procedures, etc.) to unplug line.	Moderate	Marginal	Low
T4	The tank farms' WFD infrastructure (e.g., pumps, valves, waste receipt facility) cannot meet the required waste retrieval production and the feed delivery rate for HLW processing, increasing mission duration and costs.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; slightly higher likelihood based on use of smaller pretreatment tanks. Consequence: The consequence of occurrence is significant; no differentiable difference in impact among alternatives (except for Alternative 17).	Increase redundancy (lines, etc.); expand spares program (pumps, valves, etc.); and/or improve preventive maintenance program.	Low	Significant	Low
T5	The 222-S Laboratory facility availability is less than that assumed, resulting in delays in HLW waste characterization and associated delays in waste retrieval and waste transfer schedules.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; higher likelihood of occurrence; characterization and process control sampling occurs in DST system and uses 222-S for analysis. Consequence: The consequence of occurrence is significant; small batch sizes and a higher number of process control samples, less buffer space (tank size), characterization delays would lead to unavailability of feed.	Install more laboratory equipment run multiple shifts, provide additional upgrades to 222-S to increase capacity, outsource sampling, and/or increase use of WTP Laboratory.	Moderate	Marginal	Low
T6	The WTP Analytical Laboratory functionality or throughput is less than adequate and unable to support waste performance and internal process control sample analyses. This will require modifications to the existing Analytical Laboratory or the construction of additional analytical laboratory facilities, delaying HLW processing operations and requiring additional project and LCCs.	Very Low	Marginal	Very Low	Likelihood: The likelihood of occurrence is very low; likelihood is lower for all alternatives (except for Alternative 1 and 5); WTP Analytical Laboratory has capacity for the HLW facility and PT Facility, if the PT Facility is not used then redundancy exists. Consequence: The consequence of occurrence is marginal; sampling in 222-S.				
T7	A leak or other failure in a DST (excluding AP 105, 106, 107 and 108) causes alteration in WFD schedules and the need for DST space to accommodate waste from the leaking/failed tank, resulting in delays in the overall HLW (and LAW) treatment schedule and an increase in LCCs.	Very High	Significant	High	Likelihood: The likelihood of occurrence is very high; DSTs have already experienced leaks; likelihood is the same for all alternatives. Consequence: The consequence of occurrence is significant; some flexibility in DST space capacity.	Build more DSTs. (Note: Alternative estimates – except Alternative 17 – do not include the cost of building more DSTs.)	Very High	Marginal	Moderate
T8	HLW pretreatment functions are planned for DSTs for which the DSTs were not intended (e.g., operation of mixer pumps in DSTs increases waste temperatures above established limits which increases risk of DST corrosion, pitting, or other DST integrity challenges), resulting in an increased likelihood of DST degradation and failure of the primary containment barrier with associated delays in the overall HLW (and LAW) treatment schedule and an increase in LCCs.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; ; based on limited time (~ 16 years) DSTs are used for pretreatment in Phase 1B. Consequence: The consequence of occurrence is significant; Phase 1B involves no caustic leaching, only washing which includes adding water and decanting.	Improve DST inspection and integrity programs; build new DSTs; and/or develop improved mixer pumps.	Low	Significant	Low
T9	HLW pretreatment and treatment facilities cannot sustain operations at assumed treatment throughput rates (e.g., design error, technology limitations), which results in extended mission duration and increased costs.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; more standard technology (similar to SRS) without black cell technology, designed with new glass model. Consequence: The consequence of occurrence is significant; HLW vitrification facility is rate limiting step.	Accept.	Moderate	Significant	Moderate
T10	A leak or other failure in a DST (AP 105, AP 106, AP 107 or AP 108) causes alteration in WFD schedules and the need for DST space to accommodate waste from the leaking/failed tank, resulting in delays in the overall HLW (and LAW) treatment schedule and an increase in LCCs.	Moderate	Critical	Moderate	Likelihood: The likelihood of occurrence is moderate; DSTs have already experienced leaks however AP 105 - AP 108 are newer, considering only 4 tanks; likelihood is the same for all alternatives. Consequence: The consequence of occurrence is critical; DFLAW required for supernate pretreatment.	Use other DSTs for redundancy.	Moderate	Marginal	Low
T11	The BOF facilities as designed and constructed do not provide the necessary utility and process support capabilities to serve WTP facilities needed for HLW feed sampling, characterization, staging and pretreatment. This will require modifications to the existing BOF facilities or construction of new supplemental BOF facilities, delaying HLW processing operations and increasing project and LCCs.	Very Low	Significant	Very Low	Likelihood: The likelihood of occurrence is very low; PT Facility not used; use BOF facilities at lowest rate. Consequence: The consequence of occurrence is significant; would require building new facilities, no differentiable difference in impact among alternatives.				

#	Risk Description	Pre-Mitigation Evaluation Likelihood	Consequence	Risk Level	Rationale	Mitigation Strategy	Post-Mitigation Evaluation Likelihood	Consequence	Risk Level
T12	The HLW mission operations extend significantly beyond the design life of facilities including DSTs, waste transfer lines, tank farm infrastructure, 242-A Evaporator, 222-S Laboratory, and new and repurposed facilities for HLW and LAW pretreatment and immobilization. Design life extension studies and authorizations are more complex than anticipated, resulting in facility upgrades and life extension or construction of replacement facilities to complete the overall HLW and LAW treatment mission.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; slightly higher likelihood than Alternatives 2, 5, 14, 15, and 16, which all have relatively same mission duration - completion in 2061 - 2064; Alternative 18 mission completion is 2075. Consequence: The consequence of occurrence is significant; HLW facility design life falls within mission duration.	Advanced planning for design life of facilities; implement life extension plans; improved rigor in inspections.	High	Marginal	Moderate
T13	The availability of sitewide infrastructure utilities and services (e.g., roads, high voltage power, raw water supply) is less than adequate to support the tank waste treatment mission, resulting in extended schedules and increased costs.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; slightly higher likelihood than Alternatives 2, 5, 14, 15, and 16, which all have relatively same mission duration - completion in 2061 - 2064; Alternative 18 mission completion is 2075. Consequence: The consequence of occurrence is significant; requires upgrade to sitewide infrastructure utilities and services.	Conduct advance planning and prepare a sitewide infrastructure plan.	High	Marginal	Moderate
T14	The skills mix and labor availability to support LAW and HLW processing in parallel are inadequate, resulting in delays to scheduled activities and extending mission execution.	Moderate	Marginal	Low	Likelihood: The likelihood of occurrence is moderate; no significant difference for all alternatives (except for Alternative 17); supplemental LAW is driver for resource requirements. Consequence: The consequence of occurrence is marginal; no differentiable difference in impacts for all alternatives (except for Alternative 17).				
O1	Glass waste loading improvements can be made by alternate glass formulations. Additional glass modeling of the HLW melters may be able to demonstrate that higher undissolved aluminum concentrations can be tolerated in the feed while still producing glass meeting the IHLW WAC and without significantly increasing the number of IHLW canisters produced. Changes in the aluminum limits may reduce or eliminate the need for caustic leaching, which could reduce the scope and cost of the HLW pretreatment facilities.	Moderate	Marginal	Low	Likelihood: The likelihood of occurrence is moderate; glass waste loading improvements have undergone laboratory testing and demonstrated only modest increases in waste loading, similar likelihood for all alternatives. Consequence: The consequence of occurrence is marginal; improvements already being realized.				
O2	Operating efficiency is higher than similar nuclear waste treatment facilities accelerating HLW mission completion with reduced LCCs.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; melters typically operate at 40% or less due to WFD issues; based on ORP studies, improved operating efficiency is achievable. Consequence: The consequence of occurrence is significant; TF, WTP and ETF efficiencies potentially realized.				

8.1.3 ALTERNATIVE 18 PROGRAMMATIC THREATS AND OPPORTUNITIES

#	Risk Description	Pre-Mitigation Evaluation Likelihood	Consequence	Risk Level	Rationale	Mitigation Strategy	Post-Mitigation Evaluation Likelihood	Consequence	Risk Level
T1	Delays in the approval (or inability to obtain approval) of new permits or changes to existing permits for HLW treatment facilities negatively impact project costs and schedules, and subsequent processing schedules and associated costs.	Very High	Critical	Very High	Likelihood: The likelihood of occurrence is very high; slightly higher likelihood due to change in flowsheet, use of DSTs, unlikely to receive approval for an on-site grout facility. Consequence: The consequence of occurrence is critical; same level of rigor for DSTs for all alternatives.	Early and ongoing dialogue with permitting authority, ensure high quality and accuracy of documentation; significant deviation, requires extensive negotiation, early action, and sequencing of inspections.	Very High	Critical	Very High
T2	The start of DFLAW is delayed (e.g., due to regulatory approvals, funding shortfalls or other project issues) resulting in delays to HLW operations.	Moderate	Critical	Moderate	Likelihood: The likelihood of occurrence is moderate; no discernable difference among alternatives. Consequence: The consequence of occurrence is critical; limited space buffer from HLW returns.	Accept.	Moderate	Critical	Moderate
T3	Safety events outside of the LAW and HLW pretreatment and treatment construction zones (e.g., noxious vapors, tank waste spills or other operational mishaps) result in work stoppage on LAW and HLW treatment projects and the implementation of additional engineered and administrative controls. leading to delays in project completion and in increased project costs.	Moderate	Marginal	Low	Likelihood: The likelihood of occurrence is moderate; considers LAW operations, likelihood is the same for all alternatives due to the length of design and construction even if a safety event occurs. Consequence: The consequence of occurrence is marginal; based on historical experience, the relative cost and schedule impact is the same for all alternatives.				

		Pre-Mitigation Evaluation					Post-Mitigation Evaluation		
#	Risk Description	Likelihood	Consequence	Risk Level	Rationale	Mitigation Strategy	Likelihood	Consequence	Risk Level
T4	Safety events outside of the LAW and HLW processing operations (e.g., noxious vapors, tank waste spills or other operational mishaps) result in work stoppage on LAW and HLW processing operations and the implementation of additional engineered and administrative controls leading to delays in operations and in increased LCCs.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; safety events occur every 5 - 7 years, slightly higher likelihood based on longer operations duration. Consequence: The consequence of occurrence is significant; based on experience, the vapors issue impacted the schedule by 2 years.	Accept.	High	Significant	Moderate
T5	Supply chain management challenges for equipment and components (e.g., limited availability of vendors with an approved nuclear quality assurance [NQA-1] program, vendor competency and quality of work, long lead procurements) adversely impact procurement costs and schedules, mission duration and LCCs.	High	Significant	Moderate	Likelihood: The likelihood of occurrence is high; slightly longer mission duration. Consequence: The consequence of occurrence is significant; there is a large volume of structures, components, and safety systems requiring an approved NQA-1 program.	Develop and maintain vendor supply chain partnerships, establish proactive measures such as duplicate vendor qualifications, and/or use advance procurements to purchase spares.	High	Significant	Moderate
T6	Funding shortfalls delay completion of design, construction, startup, and commissioning of HLW pretreatment and vitrification facilities resulting in extended HLW treatment mission duration and increased costs.	Very High	Crisis	Very High	Likelihood: The likelihood of occurrence is very high; with the exception of Alternative 17; the TPC for all alternatives is in the $38 - $55B range. Consequence: The consequence of occurrence is crisis; project suspended based on affordability.	Accept.	Very High	Crisis	Very High
T7	The schedule for completing design, construction, startup, and commissioning of the required HLW pretreatment and treatment facilities deviates from the current ACD and associated existing regulatory framework, which increases the time and level of effort required to negotiate ACD changes.	Very High	Critical	Very High	Likelihood: The likelihood of occurrence is very high; ACD based on capability and configuration; configuration deviates from agreed upon ACD requirements. Consequence: The consequence of occurrence is critical; greater deviation from capability, capacity and configuration; longer operations, more extensive negotiations.	Commence ACD negotiations early and maintain communication on changes/revisions.	Very High	Critical	Very High
T8	The National Geologic Repository, and/or the supporting HLW transportation infrastructure, is not available to allow the shipment of IHLW canisters by the date assumed for planning purposes (i.e., mid 2030s) requiring construction and operation of additional IHS facilities increasing capital investment and LCCs.	Very High	Marginal	Moderate	Likelihood: The likelihood of occurrence is very high; likelihood is the same for all alternatives; not likely the National Geologic Repository is available by mid 2030s. Consequence: The consequence of occurrence is marginal; same for all alternatives (except for Alternative 17) based on the number of cannisters produced.	Accept.	Very High	Marginal	Moderate
T9	Changes in the WAC and/or packaging requirements for IHLW disposal lead to additional HLW feed pretreatment requirements and potential changes to HLW glass formulation resulting in design changes to the HLW pretreatment facilities and causing delays in project and treatment schedules and increases in design/construction and operations costs.	Very Low	Critical	Low	Likelihood: The likelihood of occurrence is very low; may include changes to packaging requirements and/or allowable radionuclide content. Consequence: The consequence of occurrence is critical; changes in packaging requirements result in redesign of HLW vitrification facility.				
T10	New DOE directives/policies or external regulations result in Tank Farm or other non-WTP facility design changes or upgrades, reducing funding availability for design, construction, startup, commissioning, and operations of facilities required for the tank waste treatment mission.	Low	Significant	Low	Likelihood: The likelihood of occurrence is low; likelihood is low for all alternatives (except for Alternative 17 due to duration); historically DOE directives/policies have not changed significantly. Consequence: The consequence of occurrence is significant; the relative impact is the same for all alternatives.				
T11	The design, construction, startup, commissioning, and operation of HLW pretreatment and treatment facilities are delayed due to issues raised by external stakeholders (e.g., Defense Nuclear Facility Safety Board [DNFSB], GAO, IG] extending mission completion and increasing project and LCCs.	Moderate	Significant	Moderate	Likelihood: The likelihood of occurrence is moderate; likelihood based on complexity of alternative. Consequence: The consequence of occurrence is significant; the relative impact is the same for all alternatives.	Develop foundational, historically acceptable designs, and early and continuous engagement with stakeholders.	Moderate	Significant	Moderate
T12	High activity solid waste is generated that cannot be treated or disposed of (no currently defined treatment capability or disposition path) which results in increased LCCs.	Very High	Significant	High	Likelihood: The likelihood of occurrence is very high; there is certainty that all alternatives will generate waste that currently has no defined and approved treatment capability and/or disposition path. Consequence: The consequence of occurrence is significant; impact is relative for all alternatives; despite differences in quantities of melters and IX columns, there is no substantive difference in consequences among the alternatives.	Flush melters and reduce volume, develop and implement a strategy for IX columns.	Moderate	Significant	Moderate

		Pre-Mitigation Evaluation					Post-Mitigation Evaluation		
#	Risk Description	Likelihood	Consequence	Risk Level	Rationale	Mitigation Strategy	Likelihood	Consequence	Risk Level
01	A change (or reclassification) in the methodology for classifying waste as HLW in accordance with DOE Order 435.1, or a change in the interpretation of the requirements of the Order, may reduce the volume of tank waste classified as HLW resulting in scaling down the capacity of the HLW pretreatment facilities and the HLW Vitrification Facility, or potentially eliminating some of the functional requirements for these facilities thereby reducing capital and operating costs, or reducing mission duration.	Moderate	Efficient	Moderate	Likelihood: The likelihood of occurrence is moderate; waste reclassification language already published, slightly higher likelihood based on mission duration. Consequence: The consequence of occurrence is efficient; reduction in operations duration and LCCs would be substantial (10 - 20%).				

8.2 Scoring Details

The AoA team used the scoring scale summarized in Table 27 to score each evaluation criterion for each alternative, consistent with the approved Study Plan.

Table 27: Alternative Evaluation Scoring Scale

Criteria Evaluation	Score
Fully meets the criterion	1.00
Generally meets the criterion	0.75
Somewhat meets the criterion	0.50
Barely meets the criterion	0.25
Does not meet the criterion at all	0.00

Each alternative was scored for each evaluation criterion using the scoring system as described in Section 6.2 of this Addendum. Table 28 shows the AoA team's unweighted scoring results for Alternative 18.

Table 28: Alternative 18 Unweighted Scores

#	Evaluation Criteria	Alt 18 Unconstrained
EC-1	Alternative allows for earlier completion of HLW Vitrification Facility hot commissioning	1.00
EC-2	Lower HLW project Total Project Cost (TPC) range[59]	0.75
EC-3	Lower operational, technical, and programmatic risk	0.50
EC-4	Lower HLW processing Life Cycle Cost (LCC) (present value (PV) range)	1.00
EC-5	Alternative allows for earlier completion of HLW treatment	0.75
EC-6	Increased flexibility within the Tank Farm system to recover from single point failures	0.75
EC-7	Fewer IHLW canisters produced	0.50
EC-8	Lower volume of Immobilized Low Activity Waste (ILAW) generated by HLW processing	0.00
EC-9	Lower volume of secondary liquid effluent (process condensate) generated by HLW and LAW processing	0.50
	Totals	5.75

Table 29 shows the AoA team's weighted scoring results for Alternative 18.

Table 29: Scoring of Alternatives, Weighted Scores, Unconstrained Funding

#	Evaluation Criteria	NRW	Alt 18 Unconstrained
EC-1	Alternative allows for earlier completion of HLW Vitrification Facility hot commissioning	20.0	20.0
EC-2	Lower HLW project Total Project Cost (TPC) range[59]	20.0	15.0
EC-3	Lower operational, technical, and programmatic risk	20.0	10.0
EC-4	Lower HLW processing Life Cycle Cost (LCC) (present value (PV) range)	12.0	12.0
EC-5	Alternative allows for earlier completion of HLW treatment	8.0	6.0
EC-6	Increased flexibility within the Tank Farm system to recover from single point failures	8.0	6.0
EC-7	Fewer IHLW canisters produced	4.0	2.0
EC-8	Lower volume of Immobilized Low Activity Waste (ILAW) generated by HLW processing	4.0	0.0

[59] For comparative purposes, TPC includes costs for HLW Feed Preparation and Effluent Management (HFPEM) Facility, WTV, LAW Feed Evaporator (LFE), Secondary Waste Treatment, OSGF, and HLW/Pretreatment completion, while excluding ancillary/supporting projects common to all alternatives such as LAW/Balance of Facilities (BOF)/Analytical Laboratory/Direct Feed LAW (DFLAW) Completion, Hanford Shipping Facility/Interim Hanford Storage (HSF/IHS), and needed Tank Farm projects.

#	Evaluation Criteria	NRW	Alt 18 Unconstrained
EC-9	Lower volume of secondary liquid effluent (process condensate) generated by HLW and LAW processing	4.0	2.0
	Totals	100	73

8.2.1 EVALUATION DETAILS

Table 30: Rationale for Alternative Scoring, Unconstrained Funding

Evaluation Criterion 1: Alternative allows for earlier completion of HLW Vitrification Facility hot commissioning

Alt No.	Alternative Description	Score	Rationale
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.
5	HLW Pretreatment and Effluent Management in Repurposed PT Facility	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.
15	DFHLW from DSTs and Effluent Management in New HLW HEMF	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.
16	DFHLW from Double-Shell Tanks (DSTs) and HLW Feed Concentration and Effluent Management in New HEMF	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.
17	DFHLW from DSTs without HLW Effluent Management	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	1.00	In the unconstrained funding case, all alternatives are assumed to meet the date for completion of hot commissioning stipulated in the ACD and are rated Fully Meets.

Evaluation Criterion 2: Lower HLW project Total Project Cost (TPC) range[60]

Alt No.	Alternative Description	Score	Rationale
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.25	Alternative 1 has the sixth lowest TPC range, which is discernably higher than Alternative 16 and is therefore rated Barely Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	0.25	Alternative 2 has the highest TPC range but is not significantly different from Alternatives 1 and 5, and is therefore rated Barely Meets.
5	HLW Pretreatment and Effluent Management in Repurposed PT Facility	0.25	Alternative 5 has the seventh lowest TPC range, which is not significantly different from Alternatives 1 and 2, and is therefore rated Barely Meets.
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	0.50	Alternative 14 has the third lowest TPC range, is only slightly higher than Alternative 17 and is rated Somewhat Meets.

[60] For comparative purposes, TPC includes costs for TWCSF/HFPEM/HEMF/WTV, LFE, Secondary Waste Treatment, a LAWST Facility, and HLW/PT completion, while excluding ancillary/supporting projects common to all alternatives such as LAW/BOF/LAB/DFLAW Completion, HSF/IHS, needed Tank Farm projects. For Alternative 17, replacement facilities during the mission duration are also excluded.

15	DFHLW from DSTs and Effluent Management in New HEMF	0.50	Alternative 15 has the fourth lowest TPC range but is not significantly different from Alternative 14 and is therefore rated Somewhat Meets.
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	0.50	Alternative 16 has the fifth lowest TPC range but is not significantly different from Alternative 15 and is rated Somewhat Meets.
17	DFHLW from DSTs without HLW Effluent Management	1.00	Alternative 17 has the lowest TPC range, and is rated Fully Meets. Note that the TPC is for initial facilities only and does not include the capital costs associated with replacement facilities over the mission life.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	0.75	Alternative 18 is second to Alternative 17 in terms of lowest TPC and is approximately 40% less costly than Alternative 14, which has the third lowest TPC. Alternative 18 is rated Generally Meets, between the Somewhat Meets and Fully Meets of Alternatives 14 and 18, respectively.
Evaluation Criterion 3: Lower operational, technical, and programmatic risk			
Alt No.	**Alternative Description**	**Score**	**Rationale**
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.75	Unmitigated composite risk score is Moderate. Individual ratings for Operational, Technical, and Programmatic risk were in the low end of the Moderate range, therefore Alternative 1 is rated Generally Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	0.75	Unmitigated composite risk score is Moderate. Individual ratings are in the low end of the Moderate range for Operational, the high end of the Moderate range for Programmatic risk, and Low for Technical risks, therefore Alternative 2 is rated Generally Meets.
5	HLW Pretreatment and Effluent Management in Repurposed PT Facility	0.50	Unmitigated composite risk score is Moderate. Individual ratings are in the low end of the Moderate range for Operational and Technical, and the high end of the moderate range for Programmatic risks, therefore Alternative 5 is rated Somewhat Meets.
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	0.75	Unmitigated composite risk score is Moderate for Operational and Programmatic risk, and Low for Technical risk, therefore Alternative 14 is rated Generally Meets.
15	DFHLW from DSTs and Effluent Management in New HEMF	0.50	Unmitigated composite risk score is Moderate. Individual ratings are in the high end of the Moderate range for Operational and Programmatic risks and the low end of the Moderate range for Technical risks, therefore Alternative 15 is rated Somewhat Meets.
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	0.50	Unmitigated composite risk score is Moderate. Individual ratings are in the high end of the Moderate range for Operational and Programmatic risks and the low end of the Moderate range for Technical risks, therefore Alternative 16 is rated Somewhat Meets.
17	DFHLW from DSTs without HLW Effluent Management	0.50	Unmitigated composite risk score is Moderate. Individual ratings are in the high end of the Moderate range for Operational and Programmatic risks and Low for Technical risks, therefore Alternative 16 is rated Somewhat Meets.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	0.50	Unmitigated composite risk score is Moderate. Individual ratings are in the high end of the Moderate range for Programmatic risks and the low end of the Moderate range for Programmatic and Technical risks, therefore Alternative 18 is rated Somewhat Meets.
Evaluation Criterion 4: Lower HLW processing LCC (present value (PV) range)			
Alt No.	**Alternative Description**	**Score**	**Rationale**
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.50	Alternative 1 has the seventh lowest LCC, is discernable from Alternative 3, and is rated Somewhat Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	0.75	Alternative 2 has the fifth lowest LCC, is discernable from Alternative 15, and is rated Generally Meets.
5	HLW Pretreatment and Effluent Management in the Repurposed PT Facility	0.75	Alternative 3 has the sixth lowest LCC but is not statistically differentiable from Alternative 2 and is rated Generally Meets.

14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	0.75	Alternative 14 has the second lowest LCC, is discernable from Alternative 18 and is rated Generally Meets.
15	DFHLW from DSTs and Effluent Management in New HLW HEMF	0.75	Alternative 15 has the fourth lowest LCC but is not statistically differentiable from Alternative 15 and is rated Generally Meets.
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	0.75	Alternative 16 has the third lowest LCC but is not statistically differentiable from Alternative 14 and is rated Generally Meets.
17	DFHLW from DSTs without HLW Effluent Management	0.00	Alternative 17 has the highest LCC by far and is rated Does Not Meet.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	1.00	Alternative 18 has the lowest LCC and is rated Fully Meets. Note that the clustering of LCC values necessitated lowering the scores of other alternatives relative to the originally published AoA.

Evaluation Criterion 5: Alternative allows for earlier completion of HLW treatment

Alt No.	Alternative Description	Score	Rationale
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.50	HLW treatment is completed nine years later than Alternative 18 and twenty years later than Alternatives 5 and 14. This is a significant difference and therefore Alternative 1 is rated Somewhat Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	1.00	Alternative 2 has the earliest HLW treatment completion date and is rated Fully Meets.
5	HLW Pretreatment and Effluent Management in the Repurposed PT Facility	1.00	Alternatives 5 and 14 have the second latest HLW treatment completion dates but are rated Fully Meets because the difference from Alternative 2 is only about 2 years (HLW treatment completes 07/2062 for Alt 2 vs. 09/2064 for Alt 14).
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	1.00	Alternatives 5 and 14 have the second latest HLW treatment completion dates but are rated Fully Meets because the difference from Alternative 2 is only about 2 years (HLW treatment completes 07/2062 for Alt 2 vs. 09/2064 for Alt 14).
15	DFHLW from DSTs and Effluent Management in New HEMF	1.00	Alternative 15 has the third earliest HLW treatment completion date but is rated Fully Meets because the difference from Alternative 2 is only about 2-1/2 years (HLW treatment completes 07/2061 for Alt 2 and 03/2064 for Alt 15).
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	1.00	Alternative 16 has the second earliest HLW treatment completion date but is rated Fully Meets because the difference from Alternative 2 is only 1 year (HLW treatment completes 07/2061 for Alt 2 and 10/2062 for Alt 16).
17	DFHLW from DSTs without HLW Effluent Management	0.00	HLW treatment is incomplete as of CY 2168 for this alternative, with approximately 15% of HLW remaining. Completion is estimated approximately 100 later than Alternative 1 and is rated Does Not Meet.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	0.75	HLW treatment is completed eleven years later than the next better alternatives, Alternative 5 &14, which are rated Fully Meets, but also nine years sooner than Alternative 1 which is rated Somewhat Meets. Alternative 18 is rated Generally Meets.

Evaluation Criterion 6: Increased flexibility within the Tank Farm system to recover from single point failures

Alt No.	Alternative Description	Score	Rationale
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.50	See Section 8.2.2 for additional details.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	1.00	See Section 8.2.2 for additional details
5	HLW Pretreatment and Effluent Management in Repurposed PT Facility	1.00	See Section 8.2.2 for additional details
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	1.00	See Section 8.2.2 for additional details

15	DFHLW from DSTs and Effluent Management in New HEMF	0.75	See Section 8.2.2 for additional details
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	0.75	See Section 8.2.2 for additional details
17	DFHLW from DSTs without HLW Effluent Management	0.00	See Section 8.2.2 for additional details
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	0.75	See Section 8.2.2 for additional details

Evaluation Criterion 7: Fewer IHLW canisters produced

Alt No.	Alternative Description	Score	Rationale
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.75	Alternatives 1, 5 & 14 produce the same number of IHLW canisters, approximately 16% more than Alternative 2, and are rated Generally Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	1.00	Alternative 2 produces the second fewest IHLW canisters. The difference in number produced between this alternative and Alternatives 15 & 16 is not statistically significant therefore all three are rated Fully Meets.
5	HLW Pretreatment and Effluent Management in Repurposed PT Facility	0.75	Alternatives 1, 5 & 14 produce the same number of IHLW canisters, approximately 16% more than Alternative 2, and are rated Generally Meets.
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	0.75	Alternatives 1, 5 & 14 produce the same number of IHLW canisters, approximately 16% more than Alternative 2, and are rated Generally Meets.
15	DFHLW from DSTs and Effluent Management in New HEMF	1.00	Alternatives 15 & 16 produce fewest IHLW canisters and are rated Fully Meets.
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	1.00	Alternatives 15 & 16 produce fewest IHLW canisters and are rated Fully Meets.
17	DFHLW from DSTs without HLW Effluent Management	0.00	The model results for Alternative 17 indicate production of 14,900 IHLW canisters as of CY 2168, with approximately 15% of the HLW remaining to be immobilized. Extrapolating the remainder of the waste, the number of IHLW canisters produced would be more than double than for Alternatives 2, 15, and 16, and 85% more than for Alternatives 1, 5, and 14, therefore Alternative 17 is rated Does Not Meet.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	0.50	Alternative 18 produces the second highest number of IHLW canisters, approximately 26% more than alternatives 1, 5, and 14, and is rated Somewhat Meets

Evaluation Criterion 8: Lower volume of ILAW generated by HLW processing

Alt No.	Alternative Description	Score	Rationale
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.75	Alternative 1 has the second lowest number of ILAW Containers and is rated Generally Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	0.25	Alternative 2 has the fifth lowest number of ILAW Containers, is statistically worse than Alternatives 5 & 14, and is not statistically different from Alternatives 15 & 16. It is rated Barely Meets.
5	HLW Pretreatment and Effluent Management in Repurposed PT Facility	0.50	Alternatives 5 & 14 produce quantities of ILAW Containers between those produced by Alternatives 1 & 2 and are rated Somewhat Meets.
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	0.50	Alternatives 5 & 14 produce quantities of ILAW Containers between those produced by Alternatives 1 & 2 and are rated Somewhat Meets.
15	DFHLW from DSTs and Effluent Management in New HEMF	0.25	Alternative 15 has the highest number of ILAW Containers, is not statistically different from Alternatives 15 & 16, and is rated Barely Meets.

Evaluation Criterion 8: Lower volume of ILAW generated by HLW processing			
Alt No.	**Alternative Description**	**Score**	**Rationale**
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	0.25	Alternative 16 has the second highest number of ILAW Containers, is not statistically different from Alternatives 15 & 16, and is rated Barely Meets.
17	DFHLW from DSTs without HLW Effluent Management	1.00	Because Alternative 17 IHLW loading is relatively low, much of the LAW is immobilized in IHLW canisters. Extrapolating the model results from 2168 until all HLW is immobilized, the number of ILAW Containers is still lower for Alternative 17 than the other alternatives, therefore it is rated Fully Meets.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	0.00	The definition of the criterion is the volume of ILAW generated. In all other alternatives, a simple count of vitrified ILAW containers was adequate to compare the differences in volume. Alternative 18 ILAW container count from the LAW Vitrification Facility is significantly lower than that of the other alternatives. However, Alternative 18's volume of ILAW includes 543,000 cubic yards of grouted LAW produced by the OSGF in addition to the ILAW containers produced by the LAW Vitrification Facility. Alternative 18 therefore scores as the worst alternative for this criterion and it is rated Does Not Meet.

Evaluation Criterion 9: Lower volume of secondary liquid effluent (process condensate) generated by HLW and LAW processing[61]			
Alt No.	**Alternative Description**	**Score**	**Rationale**
1	HLW Characterization and Staging in New TWCSF and HLW (and LAW) Pretreatment in PT Facility (Baseline Case)	0.50	Alternative 1 produces the second lowest peak volume of process condensate produced annually, produces more than double the annual amount produced by Alternative 17 and is rated Somewhat Meets.
2	HLW Pretreatment and Effluent Management in New HFPEM Facility	0.00	Alternatives 2 and 15 produce the highest peak volume of process condensate annually and are rated Does Not Meet.
5	HLW Pretreatment and Effluent Management in the Repurposed PT Facility	0.25	Alternatives 5, 14, & 16 produce similar peak volumes of process condensate annually, produce a volume between those of Alternative 1 and Alternatives 2 & 15, and are rated Barely Meets.
14	HLW Pretreatment (with Filtration) and Effluent Management in New HFPEM Facility	0.25	Alternatives 5, 14, & 16 produce similar peak volumes of process condensate annually, produce a volume between those of Alternative 1 and Alternatives 2 & 15, and are rated Barely Meets.
15	DFHLW from DSTs and Effluent Management in New HEMF	0.00	Alternatives 2 and 15 produce the highest peak volume of process condensate annually and are rated Does Not Meet.
16	DFHLW from DSTs and HLW Feed Concentration and Effluent Management in New HEMF	0.25	Alternatives 5, 14, & 16 produce similar peak volumes of process condensate annually, produce a volume between those of Alternative 1 and Alternatives 2 & 15, and are rated Barely Meets.
17	DFHLW from DSTs without HLW Effluent Management	1.00	Alternative 17 has the lowest peak volume of process condensate produced annually, the amount is less than half that of Alternative 2, and therefore is rated Fully Meets.
18	High-Level Waste Pretreatment (with Filtration) and Effluent Management in New HEMF with Phased Startup and Off-Site Treatment	0.50	Alternative 18 produces the third lowest peak volume of process condensate produced annually, slightly more than Alternative 1, and is rated Somewhat Meets.

8.2.2 EVALUATION CRITERION 6, INCREASED FLEXIBILITY WITHIN TANK FARM SYSTEM TO RECOVER FROM SINGLE POINT FAILURES

The additional details for Criterion 6 from the Study Plan stated that, "*WRPS flowsheet modeling will determine the DST volumes and free space over time. Modeling results will also provide data on the number of required evaporator runs,*

[61] Based on volume produced annually

waste transfers, and availability of other Tank Farm facilities and infrastructure that may be needed to recover from tanks leaks or other single point failures (e.g., 242-A Evaporator and waste transfer lines).”

Since the Study Plan was developed before the AoA team fully understood the WRPS modeling constraints, the actual analysis differs slightly from the plan. Criterion 6 is scored for each alternative with consideration for the following factors:

- Cross-site transfers, applying qualitative judgment based on the average number per year and highest number in any year (Table 31)
- 242-A Evaporator campaigns, applying qualitative judgment based on the average number per year and highest number in any year (Table 31). Mission duration was also considered, since the duration of Alternative 17 makes it inconceivable that the 242-A Evaporator would not have to be replaced.
- SST retrieval completion durations, which are a function of SST retrieval delays due to lack of DST free space from modeling (Table 32).

These three sub-criteria were evaluated individually, using the same methodology used to rate alternatives relative to the nine Evaluation Criteria. The results for the sub-criteria were then averaged to determine an Evaluation Criterion 6 rating for each Alternative.

Table 31: Cross Site Transfers and Evaporator Campaigns by Alternative[62]

Alt #	Average Number of Cross Site Transfers per Year	Highest Number of Cross-Site Transfers in any Calendar Year	Average Number of 242-A Evaporator Campaigns per Year	Highest Number of 242-A Evaporator Campaigns in any Calendar Year, *Capped at 6 per Year	Total Number of 242-A Evaporator Campaigns	242-A Evaporator Utilization
1	3.6	9 (2070)	3.2	6 (Starting in 2040-45, 2056-58, 2060-66, 2068 and 2070-73)	179	9%
2	7.2	15 (2045)	0.8	3 (2049-50)	30	1%
5[63]	7.3	18 (2047)	0.6	3 (2035 and 2057)	24	1%
14	7.3	18 (2047)	0.6	3 (2035 and 2057)	24	1%
15	7	15 (2059)	1.3	5 (2049)	56	3%
16	7.7	16 (2058)	1.6	4 (2034, 2045 and 2053)	65	3%
17	2	12 (2160)	1.1	6 (2097)	158	2%
18	2.5	14 (2034, 2045, 2047, 2049, 2050)	2.6	6 (2069)	61	6%

[62] Based on TOPSim modeling results
[63] Not modeled however transfer rates are assumed to be the same as Alt 14

Table 32: SST Retrieval Durations

Alternative #	SST Retrieval Finish Date	SST Retrieval Duration (Years)
1	6/1/2073	51
2	4/1/2056	34
5	4/1/2058	36
14	4/1/2058	36
15	5/1/2059	37
16	12/2/2057	36
17	8/1/2159	138
18	8/1/2070	49
Note: SST Retrieval Start Date is 1/1/2022 for all Alternatives		

8.2.2.1 Cross Site Transfers

Alternative 17 was judged to offer the greatest degree of flexibility in consideration of the average and peak number of cross site transfers and was rated as *Fully Meets the Criterion*. It has the lowest average number per year, at 2, and although the peak number of 12 is higher than the Alternative 1 peak of 9, the extremely long mission duration of Alternative 17 offsets this factor.

Alternative 1 was judged to offer the second greatest degree of flexibility and was rated as *Generally Meets the Criterion*. The average of 3.6 transfers per year is 80% higher than Alternative 17 and approximately half of the number of transfers for the other alternatives. The peak cross site transfers per year of 9 is the lowest of all alternatives.

Alternative 18 was judged to offer the third greatest degree of flexibility. White it has a lower average number of cross site transfers per year than Alternative 1 at 2.5, it also has a higher number of peak transfers per year. This peak of 14 per year occurs in five different years for Alternative 18. The offsetting benefits of the two alternatives result in both being rated as *Generally Meets the Criterion*.

Alternatives 2, 5, 14, 15, and 16 are not significantly different from each other regarding the average and peak numbers of cross site transfers, with the average ranging from 7 to 7.7 and the peak from 15 to 18. They were judged discernably less flexible than Alternative 1 and were rated as *Somewhat Meets the Criterion*.

8.2.2.2 242-A Evaporator Campaigns

Alternative 1 stood out as having both the highest average number of campaigns per year at 3.2, more than double the average of other alternatives, the highest number of campaigns in any year, and the highest utilization rate. The model capped the number of 242-A Evaporator campaigns at six per year, and Alternative 1 reached this cap 21 times. Although Alternative 17 also reached the annual maximum of six campaigns, it only reached this limit one time. Alternative 1 was considered significantly worse than all other alternatives except Alternative 17 and was rated as *Barely Meets the Criterion*.

Alternative 17 has a low average number of campaigns per year at 1.1 and, as previously mentioned, a peak of 6 annual campaigns occurring in one year. The utilization rate for this alternative is 2%, which is between the utilization rates of Alternatives 2, 4, and 5 at 1% and Alternatives 15 and 16 at 3%. However, given the extremely long mission duration for this alternative, it is not realistic to expect that the existing 242-A Evaporator would remain available on demand. The alternative was therefore rated as *Barely Meets the Criterion*.

Alternative 18 has the second highest average number of 242-A Evaporator campaigns per year at 2.6. Like Alternative 17, Phase 1 of Alternative 18 requires a peak of six (6) annual campaigns. Alternatives 15, 16, and 18 have similar numbers of total 242-A Evaporator campaigns, but 242-A Evaporator utilization is twice as high for Alternative 18.

Overall, Alternative 18 is judged to be better than Alternatives 1 and 17, but worse than all other alternatives relative to this sub-criterion, and is rated as *Somewhat Meets the Criterion.*

Alternatives 2, 5, and 14 are statistically very similar, have the lowest utilization rates, have roughly half the total number of campaigns as Alternatives 15 and 16. These alternatives are rated as *Fully Meets the Criterion.*

The remaining Alternatives, 15 and 16, were not statistically discernable from each other but, as noted, had a much higher rate of utilization than Alternatives 2, 5, and 14 and were rated as *Generally Meets the Criterion*.

8.2.2.3 SST Retrieval Completion Durations

For Alternative 18, SST retrievals are completed in 8/2070. This is 3 years earlier than Alternative 1 but 12 years later than Alternative 14. The 8/2070 SST retrieval completion date for Alternative 18 also does not compare favorably with Alternatives 2, 15, and 16 which have SST retrieval completions dates of 4/2056, 5/2059, and 12/2057 respectively. Alternative 18 completes SST retrievals 89 years earlier than Alternative 17. The difference between SST retrieval durations for Alternatives 1 and 18 are not statistically significant, therefore both are rated *Somewhat Meets the Criterion.*

8.2.2.4 Calculation of Criterion 6 Ratings

Table 27 shows the numerical values associated with each of the criteria scoring levels, and Table 33 shows the calculated average of the sub-criteria. The spreads in the averages were used to assign an overall score for each alternative relative to Evaluation Criterion 6.

Table 33: Evaluation Criterion 6 Rating Calculation

Alternative	Cross Site Transfers	242-A Evaporator Campaigns	SST Retrievals	Average	EC-6 Rating
1	0.75	0.25	0.75	0.58	Somewhat Meets
2	0.50	1.00	1.00	0.83	Fully Meets
5	0.50	1.00	1.00	0.83	Fully Meets
14	0.50	1.00	1.00	0.83	Fully Meets
15	0.50	0.75	1.00	0.75	Generally Meets
16	0.50	0.75	1.00	0.75	Generally Meets
17	1.00	0.25	0.00	0.42	Doesn’t Meet
18	0.75	0.50	0.75	0.67	Generally Meets

8.3 Cost Estimating Details

The tables on the following pages summarize the results of the LCCE for Alternative 18 as compared to the previously reported LCCE for Alternative 14. Additional tables provide a summary of the unconstrained funding requirements for Alternative 18 and the results of the Constrained Funding Analysis, as described in Section 5.3 of this Addendum.

Table 34: WTP HLW AoA Estimated LCC (FY2020 through Completion)

		FY 2020 $		As-Spent		Present Value	
	All Amounts are $M	**Alt 14**	**Alt 18**	**Alt 14**	**Alt 18**	**Alt 14**	**Alt 18**
	Total Lifecycle Cost	**115,168**	**93,923**	**211,886**	**199,476**	**118,840**	**96,824**
	Operations Activities/Costs	**84,913**	**74,541**	**163,657**	**161,256**	**82,922**	**72,794**
5.01.01	Base Operations	8,548	10,521	15,734	22,634	8,347	10,275
5.01.02	DST Space Management	1,471	1,431	2,637	2,885	1,436	1,398
5.01.03	TOC Facility Operations	2,326	2,908	4,057	5,940	2,272	2,839
5.01.05	Project Support	4,827	5,960	9,074	13,114	4,714	5,820
5.01	**Base Operations**	**17,172**	**20,820**	**31,503**	**44,573**	**16,769**	**20,332**
5.02.01	Retrieval/Closure Program	1,687	2,088	2,852	4,064	1,648	2,039
5.02.02	SST Retrieval East Area	1,819	1,814	3,475	4,413	1,776	1,772
5.02.03	SST Retrieval West Area	3,081	3,098	5,751	6,542	3,009	3,025
5.02.04	Closure Program	152	187	275	399	148	183
5.02.05	SST Closure	2,192	2,192	4,195	5,023	2,141	2,141
5.02.07	AX-Farm Retrieval	129	129	134	134	126	126
5.02.08	A/AX Retrieval Common Upgrades & Design	0	0	0	0	0	0
5.02	**Retrieve and Close SSTs**	**9,061**	**9,509**	**16,683**	**20,574**	**8,848**	**9,286**
5.03.01	WTP Feed Delivery Program	1,632	1,943	2,925	4,135	1,593	1,897
5.03.02	TWCSF/HFPEM/HEMF/WTV/LFE Operations	1,598	1,350	3,227	3,745	1,561	1,318
5.03.04	DST Retrieval/Closure East Area	756	756	2,100	2,724	738	738
5.03.05	DST Retrieval/Closure West Area	93	93	232	306	91	91
5.03.06	Immobilization Program	1,381	1,603	2,639	3,764	1,348	1,565
5.03.07	WTP Operational Readiness	80	107	94	139	78	104
5.03.10	Secondary Waste Treatment/ETF	3,363	3,130	6,588	7,473	3,284	3,057
5.03.11	Next Generation Projects	43	43	62	62	42	42
5.03.12	Strategic Planning and Technology	186	455	214	666	181	444
5.03	**WFD/Treatment Planning / DST Retrieval/Closure**	**9,130**	**9,479**	**18,082**	**23,014**	**8,916**	**9,257**
5.04	**Supplemental Treatment**	**24,988**	**7,813**	**52,127**	**17,166**	**24,403**	**7,630**
5.05.40	TSCR System Operations	3,294	2,274	6,265	5,319	3,217	2,221
5.05.02	Remaining Treat Waste (WTP Operations)	16,649	21,996	31,618	49,477	16,259	21,480
5.05	**Treat Waste**	**19,943**	**24,823**	**37,883**	**55,828**	**19,475**	**24,242**
5.06	**Facility Closures**	**313**	**313**	**708**	**844**	**306**	**306**
5.12	**TOC - ORP Project Support**	**3,117**	**3,882**	**5,716**	**8,349**	**3,044**	**3,791**
	Ramp-Down	**(2,847)**	**(5,647)**	**(6,810)**	**(16,771)**	**(2,780)**	**(5,515)**

	All Amounts are $M	FY 2020 $ Alt 14	FY 2020 $ Alt 18	As-Spent Alt 14	As-Spent Alt 18	Present Value Alt 14	Present Value Alt 18
	Fee	**4,035**	**3,550**	**7,765**	**7,679**	**3,940**	**3,466**
	Capital and Expense Funded Projects	**30,255**	**19,382**	**48,230**	**38,219**	**35,918**	**24,030**
5.01.04.01.01	242-A Evaporator Upgrades	346	284	715	497	440	341
5.01.04.01.07	Cross-Site Slurry Line	65	0	82	0	70	0
5.01.04.01.30	Cross-Site Supernate Transfer Line	36	0	44	0	38	0
5.01.04	Other Tank Farm Upgrade Projects	1,069	1,373	2,601	4,401	1,445	2,039
5.02.01.06.01	B-Complex Waste Receiver Facility (WRF)	385	385	625	1,195	455	588
5.02.01.06.02	T-Complex Waste Receiver Facility (WRF)	395	395	871	1,379	527	632
5.03.02	Construct DST Systems	1,265	1,291	2,248	2,682	1,513	1,625
5.03.02.19.01	TWCSF/HFPEM/HEMF/WTV	1,534	2,159	2,118	5,084	1,700	2,944
5.03.02.19.04	LAW Feed Evaporator (LFE)	346	407	542	984	403	561
5.03.06.04	Hanford Shipping Facility (HSF)	170	170	247	488	192	252
5.03.06.06	IHS	202	202	315	315	235	235
5.03.10.01	Secondary Liquid Waste Treatment	670	550	997	1,533	765	805
5.04.01.08.01	LAWST Facility/On-site Grout Facility	12,508	1,205	20,590	3,038	15,590	1,693
5.05.40	TSCR System	1,559	1,248	3,806	4,185	2,122	1,885
	West Area Load Out Station	0	9	0	11	0	9
5.05.02.02	Start-up and Commissioning/Transition - TOC	258	258	348	348	282	282
5.05	LBL/DFLAW Completion	2,261	2,261	2,358	2,358	2,245	2,245
	Additional ETF Modifications	96	96	100	100	92	92
5.05	HLW/PT Completion	7,090	7,090	9,621	9,621	7,801	7,801

Table 35: Unconstrained Funding Summary

	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40
HLW Completion	650	876	1,130	1,142	1,331	1,462	834	549	968	273	0	0	0	0	0	0	0
Base Operations and Other Phase 1 Costs	1,164	1,306	1,452	1,621	1,513	1,423	1,435	1,557	1,587	1,578	1,644	1,681	1,759	1,782	1,826	1,829	1,846
Phase 1b Construction Projects	34	27	6	1	7	16	12	3	1	8	19	15	4	1	10	24	18
Phase 1b Operations Costs	39	16	155	308	300	306	338	321	324	357	329	371	385	396	404	426	357
Phase 2 Construction Projects	0	0	0	0	0	0	0	0	0	0	138	190	244	312	346	369	415
Operation of Phase 2 Facilities (excl new ETF)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,886**	**2,224**	**2,743**	**3,072**	**3,151**	**3,206**	**2,619**	**2,431**	**2,880**	**2,217**	**2,130**	**2,258**	**2,392**	**2,491**	**2,586**	**2,646**	**2,637**
Constrained Funding Cap	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Cumulative Funding Available (assumes carryover possible)	**614**	**889**	**647**	**74**	**(576)**	**(1,283)**	**(1,402)**	**(1,333)**	**(1,713)**	**(1,430)**	**(1,060)**	**(817)**	**(709)**	**(700)**	**(785)**	**(932)**	**(1,068)**

	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49	FY50	FY51	FY52	FY53	FY54	FY55	FY56
HLW Completion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base Operations and Other Phase 1 Costs	1,934	1,986	2,020	2,134	2,250	2,318	2,438	2,589	2,615	2,795	2,937	2,848	3,142	3,264	3,072	3,065
Phase 1b Construction Projects	5	1	12	29	22	6	2	15	35	27	7	2	18	42	33	9
Phase 1b Operations Costs	222	211	171	167	261	354	330	353	449	381	381	474	284	294	546	624
Phase 2 Construction Projects	717	907	946	992	1,001	1,320	1,121	832	993	717	507	567	232	112	0	0
Operation of Phase 2 Facilities (excl new ETF)	0	0	0	0	0	0	0	0	0	0	236	269	275	282	288	295
Total	**2,878**	**3,106**	**3,150**	**3,322**	**3,534**	**3,997**	**3,890**	**3,789**	**4,092**	**3,920**	**4,068**	**4,160**	**3,951**	**3,994**	**3,939**	**3,993**
Constrained Funding Cap	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Cumulative Funding Available (assumes carryover possible)	**(1,446)**	**(2,052)**	**(2,703)**	**(3,524)**	**(4,558)**	**(6,055)**	**(7,445)**	**(8,735)**	**(10,327)**	**(11,747)**	**(13,315)**	**(14,975)**	**(16,426)**	**(17,920)**	**(19,359)**	**(20,852)**

Table 36: Constrained Funding Summary

	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40
HLW Completion	650	876	1,130	1,142	1,331	1,462	834	549	968	273	0	0	0	0	0	0	0
Base Operations and Other Phase 1 Costs	1,164	1,306	1,452	1,621	1,513	1,423	1,435	1,557	1,587	1,578	1,644	1,681	1,759	1,782	1,826	1,829	1,846
Phase 1b Construction Projects	0	0	0	0	0	0	0	16	46	38	9	1	9	22	17	4	1
Phase 1b Operations Costs	0	0	0	0	15	29	28	15	47	19	187	373	362	370	409	388	392
Phase 2 Construction Projects	0	0	0	0	0	0	0	0	0	0	138	190	244	312	346	369	415
Operation of Phase 2 Facilities (excl new ETF)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,814**	**2,181**	**2,582**	**2,763**	**2,859**	**2,913**	**2,296**	**2,138**	**2,648**	**1,908**	**1,977**	**2,245**	**2,374**	**2,485**	**2,598**	**2,590**	**2,654**
Constrained Funding Cap	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Cumulative Funding Available (assumes carryover possible)	**686**	**319**	**923**	**660**	**301**	**(112)**	**92**	**454**	**306**	**898**	**1,421**	**1,676**	**1,802**	**1,816**	**1,719**	**1,629**	**1,474**

	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49	FY50	FY51	FY52	FY53	FY54	FY55	FY56
HLW Completion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base Operations and Other Phase 1 Costs	1,934	1,986	2,020	2,134	2,250	2,318	2,438	2,589	2,615	2,795	2,937	2,848	3,142	3,264	3,072	3,065
Phase 1b Construction Projects	11	26	21	5	1	14	32	25	7	2	17	39	30	8	2	21
Phase 1b Operations Costs	432	397	448	466	479	488	514	432	269	255	207	202	315	428	399	427
Phase 2 Construction Projects	717	907	946	992	1,001	1,320	1,121	832	993	717	507	567	232	112	0	0
Operation of Phase 2 Facilities (excl new ETF)	0	0	0	0	0	0	0	0	0	0	236	269	275	282	288	295
Total	**3,095**	**3,317**	**3,436**	**3,597**	**3,731**	**4,140**	**4,106**	**3,878**	**3,884**	**3,769**	**3,904**	**3,926**	**3,995**	**4,093**	**3,761**	**3,808**
Constrained Funding Cap	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Cumulative Funding Available (assumes carryover possible)	**880**	**63**	**(873)**	**(1,970)**	**(3,201)**	**(4,841)**	**(6,446)**	**(7,824)**	**(9,208)**	**(10,477)**	**(11,881)**	**(13,307)**	**(14,801)**	**(16,395)**	**(17,655)**	**(18,963)**

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